Industry Foundation Classes - Release 2.0

Specifications Volume 1

AEC/FM Processes Supported By IFC

Beta - 10-January-99

International Alliance for Interoperability
Enabling Interoperability in the AEC/FM Industry

Industry Foundation Classes - Release 2.0

Specifications Volume 1

AEC/FM Processes supported by IFC

Enabling Interoperability in the AEC/FM Industry

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Alpha	Richard See	10-Aug-98	Alpha release
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Table of Contents

1. Introduction, Scope and Assumptions

1.1. Purpose of these documents

The purpose of this document suite is to provide a detailed specification of the Industry Foundation Classes (IFC) as defined by the Industry Alliance for Interoperability (IAI). The intended audience is the IAI membership, industry domain experts, and software developers interested in implementing IFC.

1.2. IFC Release Document Suite

IFC will be documented for two readers. The AEC professional and the software profession serving the AEC industry. Documents in this release include:

An Introduction to IAI and IFC

The "*An Introduction to IAI and IFC,"* as the name implies, provides AEC/FM industry professionals with an introduction to the organization, including its mission and organization. It also introduces the shared project model concept, end user benefits in using IFC compliant applications and summarizes the AEC Industry processes that are supported by this release of IFC. Finally, it provides a preview of what will be added in future releases.

IFC Specification Development Guide

The *"IFC Specification Development Guide"* defines the process used by the IAI in developing IFC. It also provides various references supporting parts of this process such as development of process diagrams, development of detailed requirement definitions and reading/creating EXPRESS (data model) definitions and EXPRESS-G diagrams.

IFC Object Model Architecture Guide

The *"IFC Object Model Architecture G*uide*"* defines the architecture used in the design of the IFC object model. This architecture is modular and layered which allows independent development and evolution of sub-schemata. This document is written for software developers who will develop applications supporting IFC.

Volume 1: AEC/FM Processes Supported by IFC

THIS DOCUMENT -- The "*AEC/FM Processes Supported by IFC"* volume documents the AEC/FM industry processes that the IFC Project Model in this release is designed to support. Therefore, this document effectively defines the scope of AEC project information included in this Release. Volumes 2 and 3 structure this information for use in applications. Note that this IFC release is limited to the information content of the foundation classes defined. Behavior for these objects, and thus the implementation of software that will support these AEC industry processes, will be defined by the implementing software vendors.

Volume 2: IFC Object Model Guide

The "*IFC Object Model Guide"* defines model design and use concepts for IFC object model. These key concepts include: an overview of model architecture, capturing design intent, sharing semantic relationships, model extension by application developers. It also describes some implementation strategies such as file based model exchange, Client-Server architectures and runtime interoperability supported through standard software interfaces of the IFC model. This includes provides an overview and example of the physical file format for file based model exchange.

Volume 3: IFC Object Model Reference

The "*IFC Object Model Reference"* provides detailed definitions for each of the classes and data types defined in the IFC object model. This includes all of the information required by the AEC processes defined in volume 1, structured in an information model detailing object class data, relationships, standard interfaces, type definitions and geometry schema use for shape representation. Additionally, it provides a data model view defined in EXPRESS and a standard interfaces view defined in IDL. Each of these code sets will be used by application developers as input into Computer Aided Software Engineering (CASE) tools to semi-automate development of applications supporting IFC. Finally, a on-line version of this information is provided using an HTML document set that is cross linked for easy access to information related to or supporting a particular class or data type.

Volume 4: IFC Software Implementation Certification Guide

The "*IFC Software implementation Certification Guide"* provides detailed information about conformance certifications issues and the methodology that will be used by the IAI to certify applications for multiple levels of IFC conformance. This includes an overview of the concepts for conformance assessment and certification, definition of various "Exchange Set" subsets of the IFC model for which certification can be assessed and an overview of the testing suites that will be used for certification testing.

1.3. Scope

1.3.1. Scope for IFC Release 2.0

Enabling interoperability between applications by different software vendors is the ultimate goal of the IAI. This is a very ambitious goal and will be achieved through a series of incremental steps.

In general, the IAI is focused on providing three things in IFC:

1. Standard definitions for the attributes associated with entities comprising an AEC/FM project model (objects)
2. Structure and relationships between these entities from the point of view of various AEC/FM professionals
3. Standard formats/protocols for two methods of sharing this information:
   - *exchange via a standard file format*
   - *exchange via standard software interfaces*

It is important to note that the software interface specifications in this release will not include any application-specific behavior. Instead, these interfaces will be limited to get and set methods for the attribute and relationship information defined in the data model.

Release 1.5 of IFC provided the infrastructure that supports this release, plus reasonable models for architecture, some HVAC, estimating, scheduling and Facilities Management. This release will build on these foundations and extend the model in several areas.

The scope for this release of the IFC Specifications is limited to:

1. Six AEC/FM domains - Architecture, HVAC engineering, codes and standards, cost estimating, facilities management and simulation
2. Only a specific subset of the processes in these domains (defined in Volume 1 of these specifications).

These domains and processes are:

Architectural Design

- *Building 'shell' design*
- *Building 'core' design*
  - *Stair design*
  - *Public toilet design*
- *Roof design*
- *Fire Compartmentation*

HVAC Engineering

- *HVAC Duct System Design*
- *HVAC Piping System Design*
- *Pathway Design and Coordination*
- *Building Heating and Cooling Load Calculation*

Codes and Standards

- *Commercial and Residential Energy Code Compliance Checking*

Cost Estimating

- *Cost Estimating*
  - *Identify Objects*
  - *Identify Tasks Needed to Install Objects*
  - *Identify Resources Needed to Perform Tasks*
  - *Quantify*
  - *Costing and Cost Summarization*

Facilities Management

- *Property Management*
  - *Enabling the use of IFC objects in property management*
  - *Grouping IFC objects*
  - *Linking the maintenance objects to the IFC objects*
- *Occupancy Planning*
- *Design of Workstations*
- *Floor Layout of Workstations for an Open Office*

Simulation

- *Photo Accurate Visualization*

All AEC domains

- *Project document management*

1.3.2. Scope of this document

This document includes the following information:

1. **Introduction, Scope and Assumptions**

   Provides the reader with an introduction to the set of seven documents comprising this release of the IFC Specifications. This section outlines the information included in this document versus related documents. It will also define the scope for this release and assumptions about knowledge of the reader.

2. **AEC/FM Process Framework**

   This section provides an overview of the AEC industry processes that are performed through out the design, engineer, build, and management of a built facility. The diagrams are meant to be a framework for the reader of these documents to provide an orientation for indicating where a process fits into the building lifecycle. Processes defined and supported in previous releases are indicated as gray shaded process boxes. Processes defined in this release are indicated with by black shaded process boxes.

3. **AEC Processes and Usage Scenarios**

   This section includes the process definitions and usage scenarios which are the basis for the information requirements specified in the next section - and ultimately, for the extensions to the IFC model in this release. The specified processes were prioritized and selected as processes that would see significant improvements (efficiency, cost avoidance, etc.) if supported by IFC. There are a few criteria used to do this. First, IFC support for the process must provide an increase in productivity and must be concise enough to be completed in a single IFC release cycle. Second, the process should deliver a benefit to other domains in the building life cycle. Third, there must be a minimum of two software companies that have committed that they will implement support for the process and associated IFC objects in a shipping software product.

   Such processes obviously vary between companies and certainly between regions. The definitions specified represent the IAI domain groups' consensus on a generalized definition that sufficiently represents the diversity across companies and regions. It is anticipated that future releases of IFC will reflect some regional differences.

   Each process in this section contains three parts. The first provides an overview process description, written to AEC professionals, to indicate where the process fits into their overall processes. The second part is a process diagram which illustrates each task in the process and its informational input/output sources. The third part provides text book style task definitions and a running series of usage scenarios using real project graphics and data. These are organized according to the tasks in the process diagram.

4. **Information Requirement Analyses**

   This section provides a detailed analysis for all of the input information required and output information supplied by each of the process tasks defined in section 3.

5. **Model Design Validation**

   This section includes Test Cases, which correspond to the Usage Scenarios defined in Section2. Each test case includes the definition of real world sample data sets that should be possible with any software implementation of the IFC model specified in this release. These test cases serve two purposes. First, they have been used as a tool for validating the object model; ensuring that all of the information required by each process is captured in the model correctly. Second, the test cases validate that information developed in a process is captured in a form that will be useful to other downstream processes. In most cases, the test case data comes from a real world project - the PeopleSoft headquarters building in California..

1.4. Assumptions and Abbreviations

This document assumes the reader is reasonably familiar with the following:

- AEC/FM market and project terminology
- Software industry terminology
- Concepts and terminology associated with object oriented software

The following abbreviations are used throughout the IFC Specifications:

- AEC/FM Architectural, Engineering, Construction and Facilities Management
- IAI Industry Alliance for Interoperability
- AP Application Protocol
- Arch Architecture
- CM Construction Management
- CORBA Common Object Request Broker Architecture
- COM Microsoft's Component Object Model
- DCE Distributed Computing Environment
- DCOM Microsoft's Distributed Component Object Model
- DSOM IBM's Distributed System Object Model
- FM Facilities Management
- FTP File Transfer Protocol
- GUID Globally Unique Identifier
- HVAC Heating, Ventilating and Air Conditioning
- HTTP Hypertext Transport Protocol
- IAI International Alliance for Interoperability
- IDL Interface Definition Language
- IFC Industry Foundation Classes
- ISO International Standards Organization
- FM Facilities Management
- MIDL Microsoft's Interface Definition Language
- ODL Microsoft's Object Description Language
- OMG Object Management Group
- ORB Object Request Broker
- OSF Open Software Foundation
- RPC Remote Procedure Call
- SOM IBM's System Object Model
- STEP Standard for the Exchange of Product Model Data
- TCP/IP Transmission Control Protocol/Internet Protocol
- TQM Total Quality Management
- URL Universal Resource Location

1.5. International Alliance for Interoperability (IAI)

The IAI is a ‘not for profit’ industry alliance of companies. Its membership is comprised of visionary companies representing all sectors of the AEC industry worldwide.

The IAI was first formed in September of 1995, by 12 industry leading companies who, during the previous year had worked together to develop proof of concept prototypes demonstrating the viability of interoperability between AEC software applications. This demonstration was shown publicly at the AEC Systems ’95 conference in Atlanta, Georgia. This is the third release of IFC since that time. There are currently 50 organizations implementing software to support IFC, a number that is growing quite rapidly now.

As of this printing, the IAI includes 9 international chapters with hundreds of member companies in the following regions:

- *Australasian countries*
- *French speaking region of Europe*
- *German speaking region of Europe*
- *Japan*
- *Korea*
- *Nordic countries of Europe*
- *North America*
- *Singapore*
- *United Kingdom*

The IAI stated Vision, Mission and Values can be summarized as:

VISION

Enabling Interoperability in the A/E/C/FM Industry

MISSION

To define, promote and publish specifications for the Industry Foundation Classes (IFC) as a basis for information sharing through the project life cycle, globally, across disciplines and technical applications.

VALUES

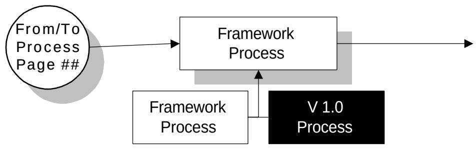
- Not for profit industry organization
- Action oriented (Alliance v. Association)
- Consensus based decision making
- Incremental delivery (rather than prolonged study)
- Global solution
- Industry to define IFC
- IFC to be “open” (for implementation/use by all software vendors)
- Design for IFC to be extensible
- IFC will evolve over time
- Membership open to any company working in construction industry

2. AEC/FM Industry Process Framework

*((** Note: this section will be replaced with the new process framework, resulting from the CB-1 project before the final release. **))*

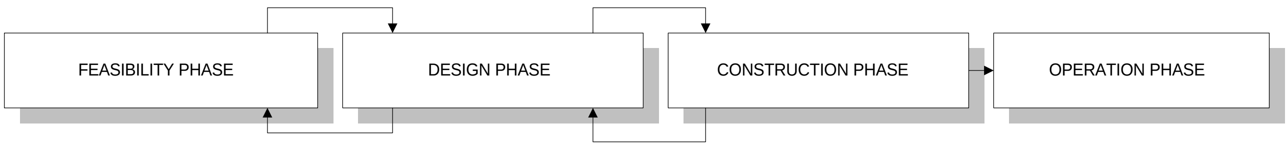
This section includes diagrams expressing the overall framework for the AEC/FM industry. There are three levels of diagrams. The first diagram represents the four phases of a project as an index into the decision to build, design, construct, and operate a facility through its entire lifecycle. The second set of diagrams presents each phase as events that evolve through that phase and are accomplished as tasks by participating disciplines. The third set of diagrams are the detailed processes developed during the IFC version 1.0 specification process.

KEY:



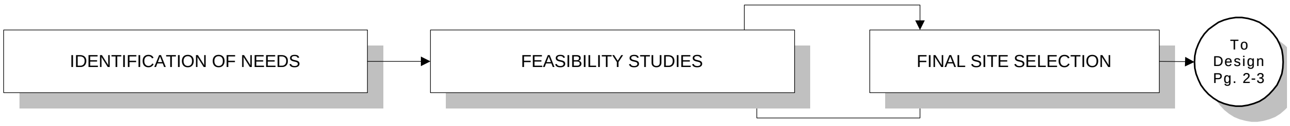
2.1. General Phases of a Building Project

The diagrams below represent the traditional AEC/FM processes where the four phases are represented as linear processes accomplished over time even though cycles exist within the phases and between phases. Each of the phases has a discipline which is responsible contractually for the completion of the phase. Disciplines may span across the phase but usually their input represents overseeing previous work for which they were responsible. Each of the following phases is described to provide the reader with a brief background.



2.1.1. Feasibility Phase

The Feasibility Phase involves the need to expand or re-arrange a facility or facilities. The process involves defining the best method for the building owner, developer, or corporation to fill their long term need for space. The decision may be between renovating an existing building, leasing space, building a new facility, or any combination of the above. At this point, a program is created by the client, facility programming consultant, or an architect to determine the capacity of the facility. Other related issues are researched that may impact the project both legally or financially.



Determine function of proposed facility
Property & building size required
Infrastructure needs of new facility
Financial resources available and needed

Potential Site Selection
- -Traffic flow
- -Zoning
- -Location
- -Lot size
- -Financial terms
- -Infrastructure requirements
- -Seek potential investors

Market Analysis
- -Competition
- -Demographics
- -Projected cashflows
- -Seek potential tenants

Conceptual Design
- -Architect selection & contracts
- -Conceptual design
- -Conceptual estimates
- -Conceptual schedule

Financial
- -Real estate commissions
- -Loan commitments
- -Investor agreements

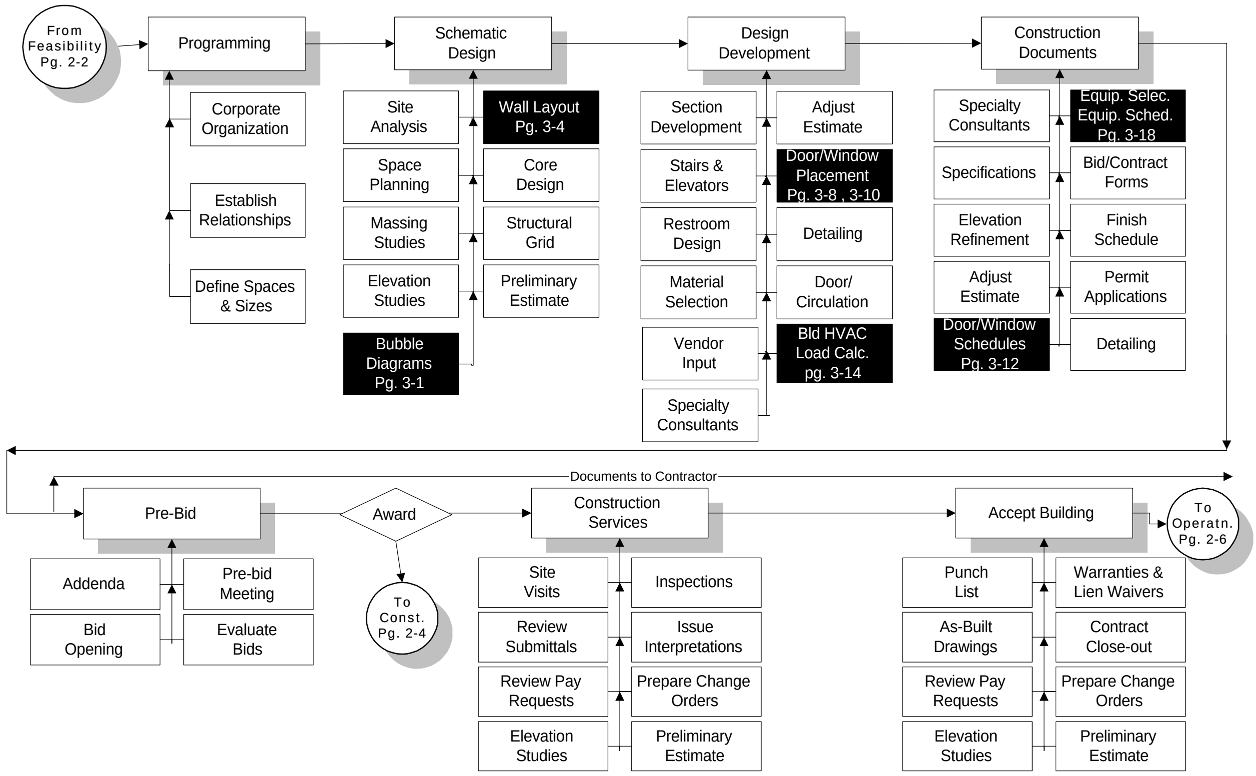
Marketing
- -Pre-construction tenant commitments
- -Public Relations

City Approval
- -Legal representation
- -Project presentation to city & public
- -Public announcements & hearings
- -Relations with property abutters
- -City development office agreements
- -Environmental impact studies

Legal Requirements
- -Title search and property survey
- -Closing documents

2.1.2. Design Phase

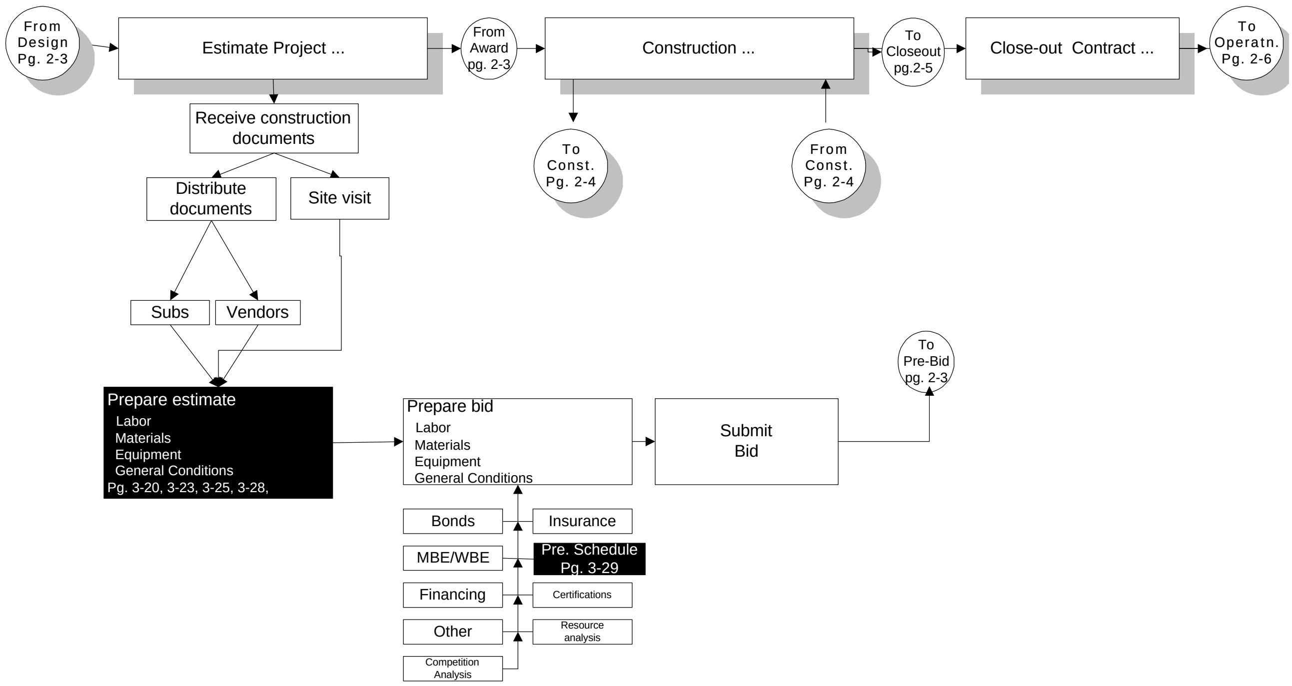
Depending on the decision in the previous Feasibility Phase, the Design Phase may range from just the interior layout and design of existing space up to the design of a new facility using the full range of disciplines, ie. architecture, interior, engineering, and specialty consultants. The traditional project has the architect, through contracts with the client, responsible for the final product of this phase, which is a set of drawing and specifications in electronic or paper format. The drawings provided by the rest of the team in this process such as the engineers are rolled up with the architects as a single set of information for the construction of the facility.



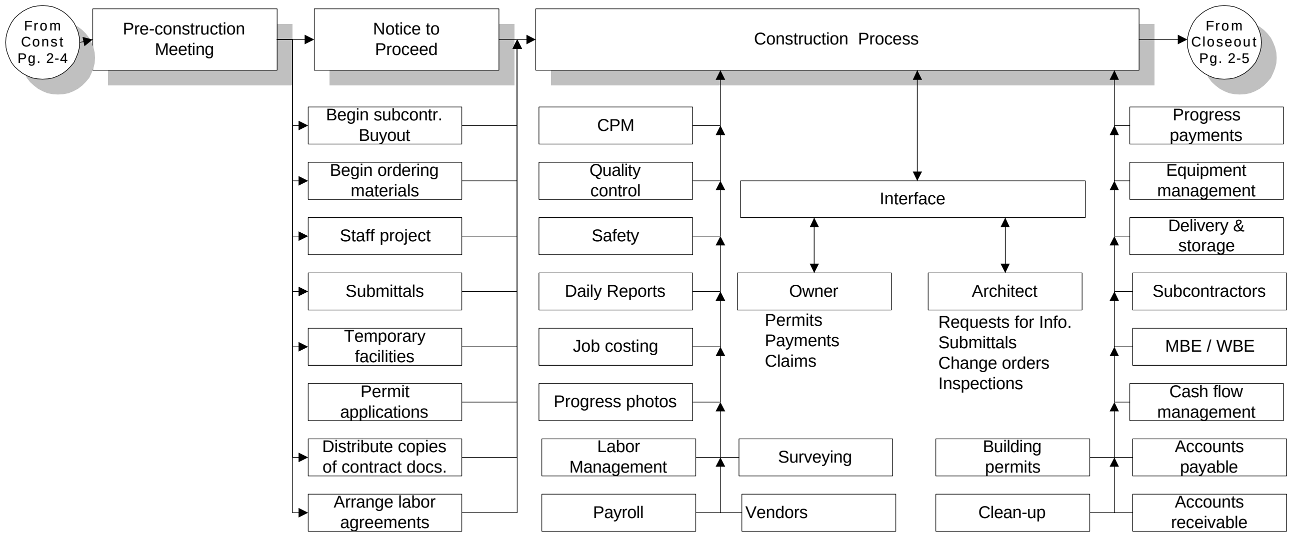
2.1.3. Construction Phase

The Construction Phase begins with an analysis of the drawings and specification documents to create an estimate on time, equipment, material, and manpower needed to construct the facility. The contractor is selected usually as part of a Bid Process where competing estimates allow the client to determine the appropriate company to build the project. A construction manager may be hired by the client to oversee the transition between the design phase and construction phase and provide scheduling and financial management for the project.

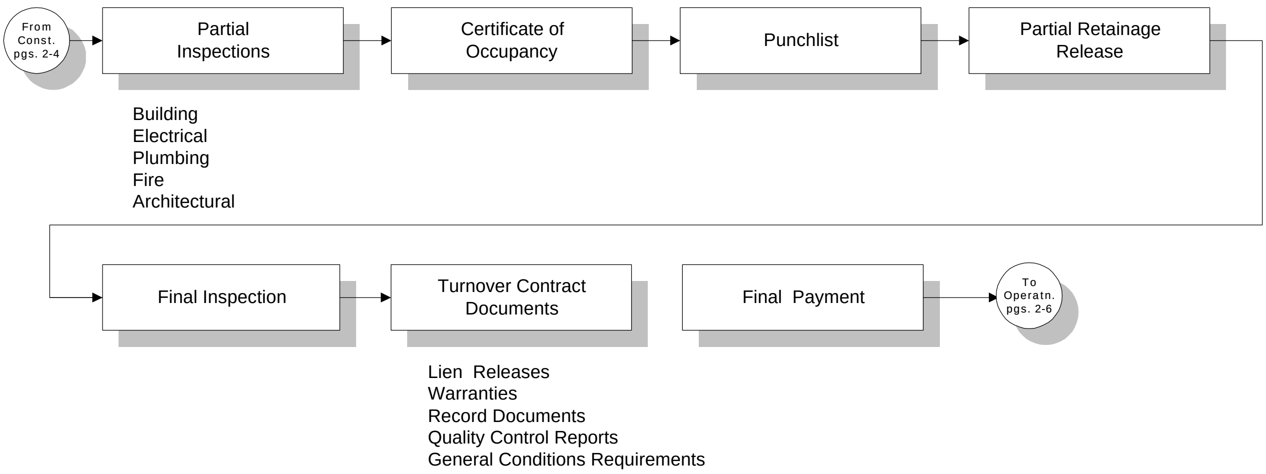
2.1.3.1. Project Estimation Processes



2.1.3.2. Construction Process

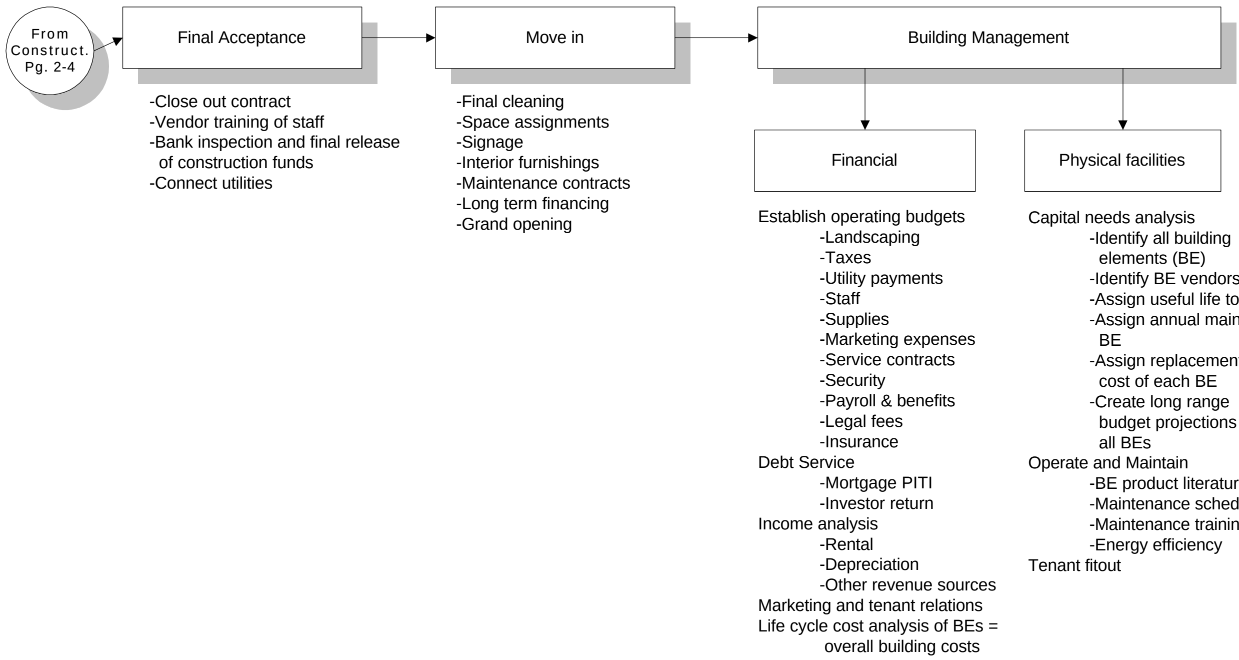


2.1.3.3. Close-Out Processes



2.1.4. Operation Phase

By far the Operation Phase is the longest and most expensive of the four phases outlined. The Operation Phase begins after the contractor turns over a finished building and the client receives an occupancy permit that indicate that the facility is inhabitable. The operation phase has many cycles and involves a large array of specialties to manage, track, operate, and maintain the facility through its continued life.



3. Release 2 Domain Project Summaries

3.1. [AR-1] Architectural Model Extensions

3.1.1. Project Description

AEC Industry Processes described in this project:

- Shell Design
- Core Design
- Stair Design
- Restroom Design
- Roof Design

This project will define these five processes in an effort to complete the basic Architectural Model for a commercial office building. These processes span from the Schematic design phase of Architecture through refinement in the Construction Document phase.

3.1.2. Project Team

Project Leader Ken Herold - North America – Ken.Herold@hok.com

Chap	Name	Company	Phone	Email	Hrs / Wk
NA	Gustavo A. Lima	Cannon		glima@cunnon.com	
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	Nick Reveliotty	The Kling Lindquest Pa...			
	Tony Sinisi	The Kling Lindquest Pa...		76636.1043@compuserve.com	
	Beth Brucker	USA-CERL		B-Brucker@cecer.army.mil	104 Hr
	Paul Lewis	Visio		paull@visio.com	
	Rob Wakeling	Visio		robw@visio.com	

3.1.3. Scope of Work

# of AEC processes to be supported	-	6	Est. total AEC expert time (days)	-	30.2
Expected IFC Model Impact (1 *(min)* to 5)	-	4	Est. total Info Modeling expert time (days)	-	??
Degree of technical difficulty (1 *(min)* to 5)	-	4	Est. total Project Mgmt. expert time (days)	-	??

3.1.4. Resources Required / Committed

Member Company Resources	**Reqired Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Process Model	30	$10,195		nn	nn

Usage Requirements	30	$10,195		nn	nn
Object Model development	30	$10,195		nn	nn
Integration	7.5	$2,600		nn	nn
Test Case development	37.75	$12,740		nn	nn
Implementation technical support	7.5	$2,600		nn	nn
Management and Review	7.5	$2,600		nn	nn
Total Member Company Resources	**151**	**$51,000**		nn	nn
Travel		**$68,000**			
Project Support	**Required Days**	**Market Value**			
Technical support	nn	$nn			
Project management	nn	$nn			
Publication and Administration	nn	$nn			
Equipment and software	nn	$nn			
Travel and subsistence	nn	$nn			
Total Project Support	**nn**	**$nn**			
Total for Project	**nn**	**$nn**			

3.2. [AR-2] Compartmentation of Buildings

3.2.1. Project Description

AEC Industry Processes described in this project:

- Compartmentation of Building

It is assumed that the fire usually starts in one place, and spreads to other parts of the building. In order to allow the occupants of the building to escape, the first thing is to stop the spread of fire and smoke to other parts of the building, as well as to maintain common escape routes free of fire and smoke. Compartmentation allows the control of fire within a limited space, allowing occupants of the building to escape and to control the fire.

On receipt of Architects drawings, identify primary and secondary Use Classes, for the total project. In doing so define shape and size of each Use Class compartments will be defined. Use Class compartments [Proposed Compartments] may need to be sub-divided into Occupancy type [Owners/Tenants] compartments and if necessary sub-divided further to meet the maximum permitted floor area or the volume for a given compartment. Final result is the Fire compartment.

3.2.2. Project Team

Project Leader ***Jay Patankar -*** *patankar@dial.pipex.com*

Chap	*Company*	*Member*	*Phone*	*Email*	*Hrs / Wk*
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UK		John Cann			
UK		David Clarke		David.clarke@eur.autodesk.com	
UK		Jeffrey Wix		100125.2426@compuserve.com	

UK		Donald Ross		ssi@ltd.net	
UK		Richard Harpham		richard_harpham@compuserve.com	

3.2.3. Scope of Work

# of AEC processes to be supported	-	3	Est. total AEC expert time (days)	-	30
Expected IFC Model Impact (1 *(min)* to 5)	-	5	Est. total Info Modeling expert time (days)	-	40
Degree of technical difficulty (1 *(min)* to 5)	-	4	Est. total Project Mgmt. expert time (days)	-	??

3.2.4. Resources Required / Committed

Member Company Resources	**Reqired Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Requirements definition					
Process Model	30	£13200			
Usage Scenaria	20	£8800			
Model design					
Object Model development *(w/ tech.Support)*	40	£17600			
Integration *(w/ tech.Support)*	10	£4400			
Design and Implementation validation					
Test Case development	20	£8800			
Review/feedback on implementations	40	£17600			
Project Management					
Project management and administration	34	£14960			
Travel and Meetings	80	£35200			
Total Member Company Resources	**274**	**120560**			

Model/Specification development support	**Required Days**	**Market Value**			
Technical support	50	£12500			
Project management	24	£10500			
Publication and Administration	10	£2200			
Equipment and software		£2000			
Travel and subsistence		£2000			
Total Project Support		**£29200**			
Total for Project		**£149760**			

3.3. [BS-1] HVAC System Design

3.3.1. Project Description

AEC Industry Processes described in this project:

- HVAC Duct Design
- HVAC Piping Design

These processes will involve utilizing the network object types defined in the IFC 2.0 Core model. This effort will be led by the North American Building Services Committee, but will be an international collaborative effort. This will ensure that the resulting system design extensions are globally applicable.

Engineers responsible for the design of duct and piping systems may be consulted during the building conceptual stage. However, the major design effort occurs after the architect has substantially completed the building drawings. The design process includes both the schematic and detailed description of duct and piping components. These components include sections of duct and pipe, fittings, accessories such as dampers, valves, and terminals. This process also includes the connection of these components to equipment such as fans and pumps. Object types for equipment were defined in IFC Version 1.x, and are not elaborated in this proposal. The system design process also includes construction cost estimates. However, these estimates are typically performed by contractors using the drawings and specifications prepared by the Building Services engineer.

Significant cost savings will result from the application of IFC's to systems design in Building Services.

- Building geometry and construction materials used in the design of HVAC load calculations and the fluid distribution systems.
- The exchange of data between engineering design and analysis programs with manufacturers' equipment selection programs.
- The production of schedules of bill of materials for the system components.
- Producing the data for engineers cost estimates and for contractors actual construction cost estimates.
- The opportunity for integration of control components used for the operation of these systems.

3.3.2. Project Team

Project Leader ***James Forester - jim@marinsoft.com***

Chap	Company	Name	Phone	Email	Hrs / Wk
NA		John Deal		75601.1346@compuserve.com	4
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NA		James Forester		jim@marinsoft.com	4
NA		Scott Frank		sfrank@pipeline.com	2
NA		Kirk McGraw		k-mcgraw@cecer.army.mil	2
NA		Larry Schaefer		larry.schaefer@carrier.wltk.com	2
NA		Tony Sherfinski		tony.sherfinski@greenheck.com	2
UK		Jeff Wix		100342.2537@compuserve.com	2
				Total for project team =	***22***

3.3.3. Scope of Work

# of AEC processes to be supported	-	2	Est. total AEC expert time (days)	-	40
Expected IFC Model Impact (1 *(min)* to 5)	-	3	Est. total Info Modeling expert time (days)	-	40
Degree of technical difficulty (1 *(min)* to 5)	-	3	Est. total Project Mgmt. expert time (days)	-	40

3.3.4. Resources Required / Committed

Member Company Resources	**Required Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Requirements definition					
Process Model	10	$12000		10	0
Usage Scenaria	15	$18000		15	0
Model design					

Object Model development *(w/ tech.Support)*	10	$12000		5	5
Integration *(w/ tech.Support)*	20	$24000		10	10
Design and Implementation validation					
Test Case development	15	$18000		10	5
Review/feedback on implementations	15	$18000		??	??
Project Management					
Project management and administration	15	$18000		30	nn
Travel and Meetings	10	$12000		10	nn
Total Member Company Resources	**110**	**$132000**		85+	40+

Model/Specification development support	**Required Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Technical support	5	$6000			
Project management	10	$12000			
Publication and Administration	10	$12000			
Equipment and software	5	$6000			
Travel and subsistence	10	$12000			
Total Project Support	**40**	**$48000**			
Total for Project	**150**	**$180000**			

3.4. [BS-3] Pathway Design and Coordination

3.4.1. Project Description

AEC Industry Processes described in this project:

- Pathway Design and Coordination

The design of pathways contains the draft layout, the coordination and the representation of mechanical and electrical system-pathways to be installed.

This design process is carried out after the first coordination with the architect and structural engineers, and includes load estimates, energy and systems definitions required for a building.

The process ends with drawings containing the coordinated pathways for the mechanical and electrical installations (i.e. heating, cooling, air-conditioning, plumbing, fire-protection and electrical power) within a building.

3.4.2. Project Team

Project Leader   Rolf Tonke / Bertram Witz - German Chapter

Chap	Company	Member	Phone	Email	Hrs
Germany	vögtlin engineering	Felix Brückner		100737.1421@compuserve.com	0
Austria	PHi-Tech	Bernhard Fragner		fragner@phitech.co.at	0
Germany	GTS	Rainer Hirschberg		Rh@gts-software.com	40
Austria	‘ESS	Doris Huber		ess@klima2000.co.at	0

Germany	Softtech	Eberhard Michaelis		EMichaelis@softtech.com	80
Germany	Ziegler Informatics	Ulrich Paar		ziegler@caddy.de	0
Swiss	RoCAD Informatik	Robert Rottermann		100041.2347@compuserve.com	80
Germany	Triplan GmbH	Willi Spiegel		willi.spiegel@triplan.com	0
Germany	Planungsgruppe M+M AG	Rolf Tonke		100436.705@compuserve.com	120
Germany	Pit-cup GMBH	Kurt Weber		pit-cup@t-online.de	0
Germany	Planungsgruppe M+M AG	Bertram Witz			80
Germany	Kuehn Bauer Partner	Michael Kuehn jr.		mkj@kbp-futures.com	0
				Total for project team	***400***

3.4.3. Scope of Work

# of AEC processes to be supported	-	7	Est. total AEC expert time (days)	-	18
Expected IFC Model Impact (1 *(min)* to 5)	-	3	Est. total Info Modeling expert time (days)	-	15
Degree of technical difficulty (1 *(min)* to 5)	-	2	Est. total Project Mgmt. expert time (days)	-	15

3.4.4. Resources Required / Committed

Member Company Resources	**Required Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Requirements definition					
Process Model	10	$7060		nn	nn
Usage Scenaria	7	$4942		nn	nn
Model design					
Object Model development *(w/ tech.Support)*	5	$3530		nn	nn
Integration *(w/ tech.Support)*	8	$5648		nn	nn
Design and Implementation validation					
Test Case development	10	$7060		nn	nn
Review/feedback on implementations	5	$3530		nn	nn
Project Management					
Project management and administration	2	$1412		nn	nn
Travel and Meetings	3	$2118		nn	nn
Total Member Company Resources	**50**	**$35300**		nn	nn

Model/Specification development support	**Required Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Technical support	nn	$nn			
Project management	nn	$nn			
Publication and Administration	nn	$nn			
Equipment and software	nn	$nn			
Travel and subsistence	nn	$nn			
Total Project Support	**nn**	**$nn**			
Total for Project	**nn**	**$nn**			

3.5. [BS-4] HVAC Loads Calculation

3.5.1. Project Description

AEC Industry Processes described in this project:

- Building Heating and Cooling Load Calculation

Load calculations serve as the basis for all design stages of the building services design. The results of the load calculations enable the designer to dimension the plant equipment and to determine the required space for plant room.

Load calculations are an official proofing method in Germany for example the proof for heat loss protection must be given in the course of a project), a mode for calculating the heating cooling load or for the yearly dynamic load simulation:

The process terminates in the complete calculations and the data exchange into the IFC model.

3.5.2. Project Team

Project Leader Rolf Tonke / Rainer Hirschberg - German Chapter

Chap	Company	Member	Phone	Email	Hrs
Germany	vögtlin engineering	Felix Brückner		100737.1421@compuserve.com	0
Austria	PHi-Tech	Bernhard Fragner		fragner@phitech.co.at	0
Germany	GTS	Rainer Hirschberg		Rh@gts-software.com	140
Austria	'ESS	Doris Huber		ess@klima2000.co.at	0
Germany	Softtech	Eberhard Michaelis		EMichaelis@softtech.com	140
Germany	Ziegler Informatics	Ulrich Paar		ziegler@caddy.de	0
Swiss	RoCAD Informatik	Robert Rottermann		100041.2347@compuserve.com	80
Germany	Triplan GmbH	Willi Spiegel		willi.spiegel@triplan.com	0
Germany	Planungsgruppe M+M AG	Rolf Tonke		100436.705@compuserve.com	160
Germany	Pit-cup GMBH	Kurt Weber		pit-cup@t-online.de	0
Germany	Planungsgruppe M+M AG	Bertram Witz			80
Germany	Kuehn Bauer Partner	Michael Kuehn jr.		mkj@kbp-futures.com	40
				Total for project team =	640

3.5.3. Scope of Work

# of AEC processes to be supported	-	6	Est. total AEC expert time (days)	-	30
Expected IFC Model Impact (1 *(min)* to 5)	-	5	Est. total Info Modeling expert time (days)	-	20
Degree of technical difficulty (1 *(min)* to 5)	-	2	Est. total Project Mgmt. expert time (days)	-	20

3.5.4. Resources Required / Committed

Member Company Resources	**Reqired Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Requirements definition					
Process Model	14	$9884		nn	nn
Usage Scenaria	12	$8472		nn	nn
Model design					
Object Model development *(w/ tech.Support)*	5	$3530		nn	nn
Integration *(w/ tech.Support)*	8	$5648		nn	nn
Design and Implementation validation					

Test Case development	15	$10590		nn	nn
Review/feedback on implementations	8	$5648		nn	nn
Project Management					
Project management and administration	5	$3530		nn	nn
Travel and Meetings	5	$3530		nn	nn
Total Member Company Resources	**72**	**$50832**		nn	nn

Model/Specification development support	**Required Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Technical support	nn	$nn			
Project management	nn	$nn			
Publication and Administration	nn	$nn			
Equipment and software	nn	$nn			
Travel and subsistence	nn	$nn			
Total Project Support	**nn**	**$nn**			
Total for Project	**nn**	**$nn**			

3.6. [CS-1] Code Checking - Energy Codes

3.6.1. Project Description

AEC Industry Processes described in this project:

- Commercial and Residential Energy Code Compliance Checking

This project has two parts: CS-1A - ***Code Compliance Enabling Mechanism*** and CS-1B ***Energy Code Compliance Checking***. These two parts have been combined into a single project for administrative efficiency. Part A of the project will define a generic code compliance enabling mechanism that will be applicable to codes of various types; e.g., accessibility, egress, and energy. The mechanism will likely involve defining new abstract classes for code compliance in the core model. Part A will be an international collaborative effort, which will ensure that the resulting enabling mechanism is broadly applicable. Part B, Energy Code Compliance, will serve an important role in validation of the generic mechanism for a set of code applications. This work will be performed primarily by the North American Chapter and will enable established energy code compliance applications to be made IFC compliant.

Code compliance checking is performed by building designers, systems designers, and code enforcement officials. Compliance with codes begins during the programming phase when designers determine which codes apply to the building project. Preliminary code reviews are frequently performed during schematic design, and more thorough reviews are performed by members of the design team late in the design process before construction documents are complete. Building code officials perform plan reviews as part of the building permit process. Designers and code official perform drawing dimension takeoffs as necessary to ensure compliance. Information about building systems, assemblies, layout, etc. is gathered during this process and compared to the requirements for each applicable code.

Codes impact virtually all disciplines involved in building design and construction processes, and code considerations persist throughout a building's life cycle. Energy codes are strongly related to architectural, HVAC, and electrical design processes. While it would be difficult to establish a reliable estimate of time and cost savings from IFC support of code checking, the tedious nature of code review and the large cost and schedule impacts that code violations can cause suggest that there will be high demand for code checking applications. Energy codes represent an attractive application for IFC support because of their extensive requirements for building data that are already in electronic form (e.g., geometric data and lighting fixture data) and demonstrated strong demand--thousands of copies of these applications currently in use.

3.6.2. Project Team

Project Leader Rob Briggs - North America Chapter

Chap	Company	Member	Phone	Email	Hrs / Wk
N. America		Rob Briggs		rs_briggs@pnl.gov	10
Singapore		Tan You Tong		youtong@iti.gov.sg	2
France		Philippe Debras		debras@cstb.fr	2
UK		Robert Amor		trebor@bre.co.uk	1
				Total for project team =	15

3.6.3. Scope of Work

# of AEC processes to be supported	-	1	Est. total AEC expert time (days)	-	5
Expected IFC Model Impact (1 *(min)* to 5)	-	2	Est. total Info Modeling expert time (days)	-	2
Degree of technical difficulty (1 *(min)* to 5)	-	3	Est. total Project Mgmt. expert time (days)	-	2

3.6.4. Resources Required / Committed

Member Company Resources	**Reqired Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Requirements definition					
Process Model	5	$4,000		5	0
Usage Scenaria	5	$4,000		5	0
Model design					
Object Model development *(w/ tech. Support)*	10	$8,000		10	0
Integration *(w/ tech. Support)*	8	$6,400		8	0
Design and Implementation validation					
Test Case development	5	$4,000		5	0
Review/feedback on implementations	5	$3,840		5	0
Project Management					
Project management and administration	5	$4,000		5	0
Travel and Meetings	5	$7,000		5	0
Total Member Company Resources	**48**	**$41,240**		48	0

Model/Specification development support	**Required Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Technical support	nn	$nn			
Project management	nn	$nn			
Publication and Administration	nn	$nn			
Equipment and software	nn	$nn			
Travel and subsistence	nn	$nn			
Total Project Support	**nn**	**$nn**			

Total for Project	nn	$nn			

3.7. [CS-2]

3.8. [ES-1]

3.9. [FM-3]

3.10. [FM-4]

3.11. [SI-1]

3.12. [XM-2]

4. AEC/FM Industry Process Definitions

This section defines the end user domain processes to be supported by Release 2.0 of the IFC Project Model. Requirements for information to be included in the project model were driven by the processes defined herein. TQM process diagramming has been used to formalize these definitions.

To further elaborate requirements for software applications that will support these processes, detailed task definitions and user usage scenarios are also provided. In general, these usage scenarios define how the AEC domain professionals expect to be able to use applications (supporting IFC) to accomplish the associated processes specified.

Please note the model validation section which follows. It contains a series of test cases which should enable application developers to test and validate that their applications do indeed satisfy the end user requirements for each process.

As for most sections of this specification, this one is organized by AEC domains in the following order: Architectural design, HVAC engineering, Codes and Standard, Cost Estimating, Facilities Management, Simulation and All Domains.

4.1. [AR-1] Architectural Model Extensions

Processes Defined in this project:

1. Building Shell Design
2. Building Core Design
    3. Stair Design
    4. Restroom Design
5. Roof Design

4.1.1. Process: Building Shell Design

The architect balances the building massing with the elevation aesthetics while performing exterior shell design. Both processes (massing and shell design) evolve and cycle back and forth as each may change aspects of the other. The exterior shell design involves making the massing interesting while using glass fenestration, cladding materials, and details in adornment that create a scale and design motif. Other aspects of this process, that are balanced, are the need for visual access and illumination of the spaces behind the shell, and the issues of attaching and waterproofing the shell. The shell design starts typically after a preliminary space layout and during the building massing studies.

4.1.1.1. Introduction

Overview:

The architect starts the shell design by working with the preliminary stacking and blocking diagrams to determine a massing of the building, based on the floor plates created in the space layout phase. After the massing, the architect will determine the proper aesthetics effect for the building, whether the facade is connected to the outside of the structure or integrated within the structure. The fenestration is determined based on the amount of light and visual impact of the glass and openings on the facade. After the designer determines the type of materials used, preliminary heat gain/heat loss can be calculated for operational cost impact of the building shell. With the final selection of material and fenestration, a detailed design of the adornment of the facade proceeds using reveals, treatment of the materials, cornices, and other building design elements.

Process Scope:

- None defined

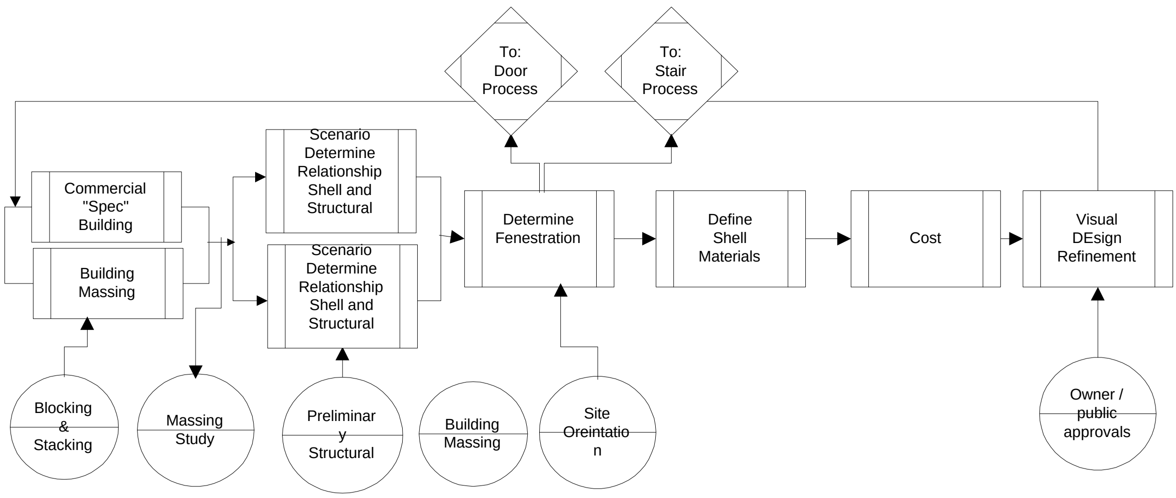
Out-of-Scope:
- block and stacking
- site analysis
- location of the building

Definitions:
- Shell - The exterior wall of a building. Other terms used (facade, elevation, building envelope
- Massing - The exterior shape of a building. A volumetric view of the building

References:
- None defined

Contributors:
- Project team

4.1.1.2. Process Diagram: Building Shell Design



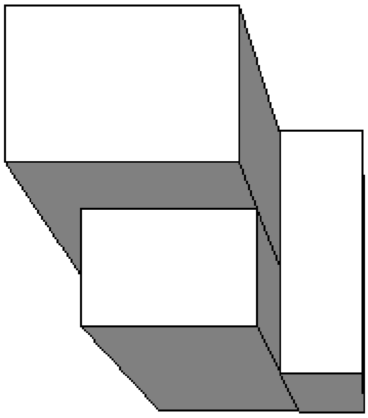
4.1.1.3. Process Definition: Building Shell Design

4.1.1.3.1. Overview

None provided

4.1.1.3.2. Task 1 - Preliminary Building Massing

Task Description:



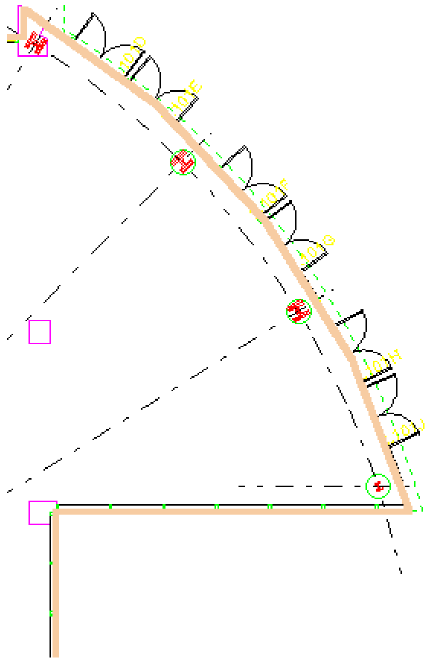
The preliminary building massing is a process that is the definition of the volume of the building shape. The massing may be constrained by regional height restrictions and open area standards which are to balance the open area on a site compared to the building footprint area. The massing will also be driven by considering the size of each floor based on a preliminary block and stacking. Client requirement such as optimizing the amount of the occupational space against the exterior wall or the number of corner offices may suggest a shape to the designer. Other subjective issues such as a desire to step the building down to a human scale may drive the massing and shape of the exterior envelope of the building. The floor to floor height of the interior spaces required by the program has a vertical impact on the massing. At this point in the process the designer will start to think about a preliminary structural grid based on a design.

Example Usage Scenario:

None provided

4.1.1.3.3. Task 2 - Determine the Relationship between Shell and Structure

Task Description:



The relationship of the shell and structure is based on the effect the architect wants to achieve with the design. For example, the shell may be attached to an edge of slab and column so the shell hangs and covers the structure. On the other hand, the designer may desire to express the structure and allow the columns and floor slabs to protrude past the shell, in effect using the structure to frame the shell areas. Other design scenarios such as using the structure to shade glass areas may suggest to the designer to extend the structure past the shell.

Example Usage Scenario:

None provided

4.1.1.3.4. Task 3 - Determine Fenestration

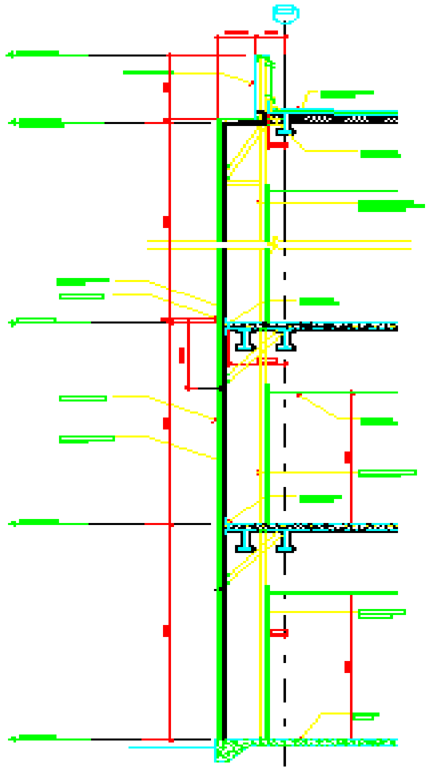
Task Description:

The fenestration is the design and placement of glass area on the shell to permit natural lighting of building spaces and views from the building. The fenestration is based on the rhythm and aesthetics effect the facade should have with respect to glass area. At this stage, a decision on the shape and size of windows are made but not detailed. The amount of glass area may be driven by the energy criteria and regional location and climate. Each facade or elevation of the shell may have a different fenestration due to the orientation of each building face compared to the direction of the sun during different seasons.

Example Usage Scenario:

None provided

4.1.1.3.5. Task 4 - Define Shell Materials



Task Description:

The selection of the shell material is based on a diverse set of criteria. The material may be picked based on the need to fit into other buildings in the area or a regional style or culture. The climate may drive the material selection process along with desires by the client to achieve a style for the building. The durability may create a narrower palate of material. There are also regional construction methods, ease of use, cost, and availability of certain materials that would affect its selection.

Example Usage Scenario:

None provided

4.1.1.3.6. Task 5 - Costs

Task Description:

A preliminary analysis may be run to determine the effect of the shell design on the construction and operational cost of the building. The upkeep on the materials along with the construction cost drive the overall life cycle cost of the shell. On the operational side of the equation the quantity and cost of energy to maintain a temperate environment will be determined by the fenestration and materials selected during the design process. Both will have an overall impact on the heat gain and loss of the building shell.

Example Usage Scenario:

None provided

4.1.1.3.7. Task 6 - Visual Design Refinements

Task Description:

At this point in the process, the shell is refined and detailed. This may include finishes, additions or treatment to materials such as flame/rough/polished stone, reveals, setting back panels, cornices, or parapets. Each of the adornments, construction techniques, and use of materials are used to apply a character to the design of the facade.

Example Usage Scenario:

None provided

4.1.2. Process: Building Core Design

The core design is a balance between making available ancillary spaces and program requirement. The size and location on a floor is determined by the structural systems, program requirements including number of occupants and building codes such as ADA. The design of the core follows the initial layout of the spaces defined in the building program. The spaces that make up the core are typically not defined in the program but are extracted by information about the floor size and occupants.

4.1.2.1. Introduction

Overview:

The core design starts by determining the size of the items needed in the core. Calculations for the number of elevators are based on building occupants and number of floors. The restroom size is based on the number of occupants on the floor and in the building. The floor to floor height is used to determine the length of the stairs which determines the size of the stairwell. The circulation around the core is determined by the type of occupancy and fire codes. The layout of the pieces of the core are driven by the structural grid and distances determined by codes, etc.

Process Scope:
- Assumptions /presumptions: space program (owners' criteria); occupancy, building, floor; parking garage impacts (structural grids); materials handling (site delivery, building services). The core is defined as items for circulation and service delivery for occupants. It does not have to be in the center of the building.

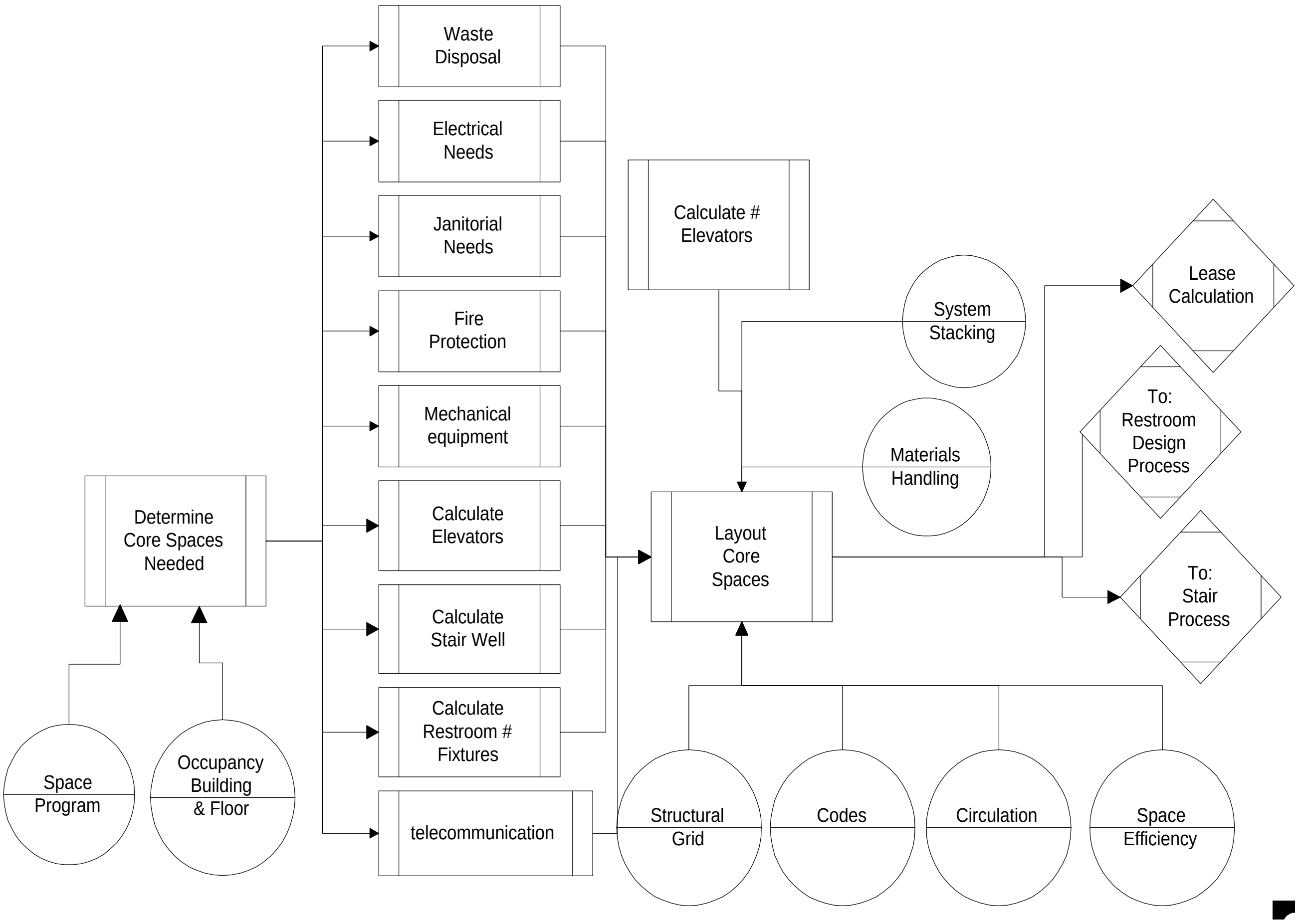
Out-of-Scope:
- This process does not address the actual design of stairs, restrooms, parking design and lobby design. Also materials handling and entering and exiting the building are not included in the core design.

Definitions:
- None defined

References:
- None defined

Contributors:
- project team

4.1.2.2. Process Diagram: Building Core Design



4.1.2.3. Process Definition: Building Core Design

4.1.2.3.1. Overview

None provided

4.1.2.3.2. Task 1 - Determine Core Spaces Needed

Task Description:

The types of core spaces are determined by a range of issues and codes. The floor occupancy, building type, and building codes determine the type and number of spaces needed as part of the core. The types of building services that are needed in the building will determine additional types of spaces to allow passage and access to services central to the buildings operation.

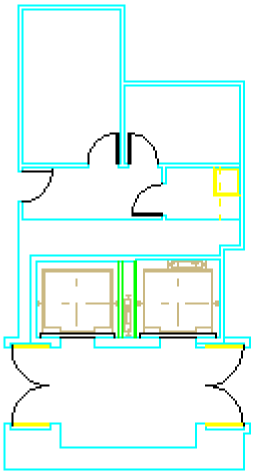
Example Usage Scenario:

None provided

4.1.2.3.3. Task 2 - Determine Core Space Sizes

Task Description:

After the determination of which spaces are included in the core for each floor the overall sizes for each needs to calculated. Apply codes and other processes to determine the size and shape of core spaces. The size of service spaces such as chases and shafts are determined by the overall amount of the material such as fluids, gases, and electrical/Telecommunications that have to be passed through and distributed to floors. Spaces used for transporting occupants such as stairs and elevators are calculated based on the volume of circulation determined by the occupancy of the floor and the building they serve. The final areas provided for occupant support such as restrooms are determined by the occupants of each of the floor they reside on.



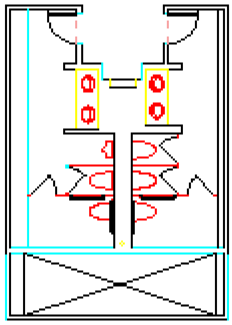
Example Usage Scenario:

None provided

4.1.2.3.4. Task 3 - Layout Core Spaces

Task Description:

The location of the varied spaces in the core is determined by many factors. One of the strongest constraints is the circulation needs for both providing effective space utilization and egress/access to the floor through stairs and elevators. The loads and timing of occupant circulation will determine the number of cabs and ultimately the number of elevator stacks and size of their corresponding shafts. The need to efficiency stacking building services forces the stacking of spaces. The structural needs for sheer walls and the spacing of vertical elements such as columns affects the placement of spaces. If the building includes levels of parking, the trade off between structural bay size and efficient parking layout to optimize the number of parking spaces will affect core element placement.



Example Usage Scenario:

None provided

4.1.2.3.5. Task 4 - Detailed Design of Stairs

Task Description:

Covered in this document under Stair design Process.

4.1.2.3.6. Task 5 - Detailed Design of Restrooms

Task Description:

Covered in this document under Stair design Process.

4.1.3. Process: Stair Design

Stair design is accomplished by working with the major elements, such as treads, landings, and railings, to determine the appropriate size of the stair and its elements. The process is an iterative process where the answer for one of the elements may change the size of another. The two factors that determine many of the size related decisions are based on the occupancy load and the exiting requirement.

4.1.3.1. Introduction

Overview:

The architect starts the stair design by working with information about the building such a location of the stair based on egress. The width and depth is defined during a process of working back and forth. The width is determined by the number of occupants traveling through the stairwell during an emergency. The width is typically defined in the local building and fire codes. The floor to floor heights of the story are used to determine the length of the stairs, based on a rise and run. The designer may then design the depth of the landing based on codes. As the design progresses to the handrail, its design can potentially affect the width of the stairs and landing, depending on the distance it protrudes into the stairwell. At the point where the size of the treads, landing, and the handrail are set, the materials and construction methods are determined. The final design involves adding items such as exit signs, doors and hardware, and emergency lighting.

Process Scope:

- The process described is for fire stairs in a building. Include fire stair materials. ADA safe haven concept should be included (telecommunications, extra design space, area impact)

Out-of-Scope:

- Ornamental stairs not in scope and not required for exiting a floor, ladders.

Definitions:

- ADA safe haven

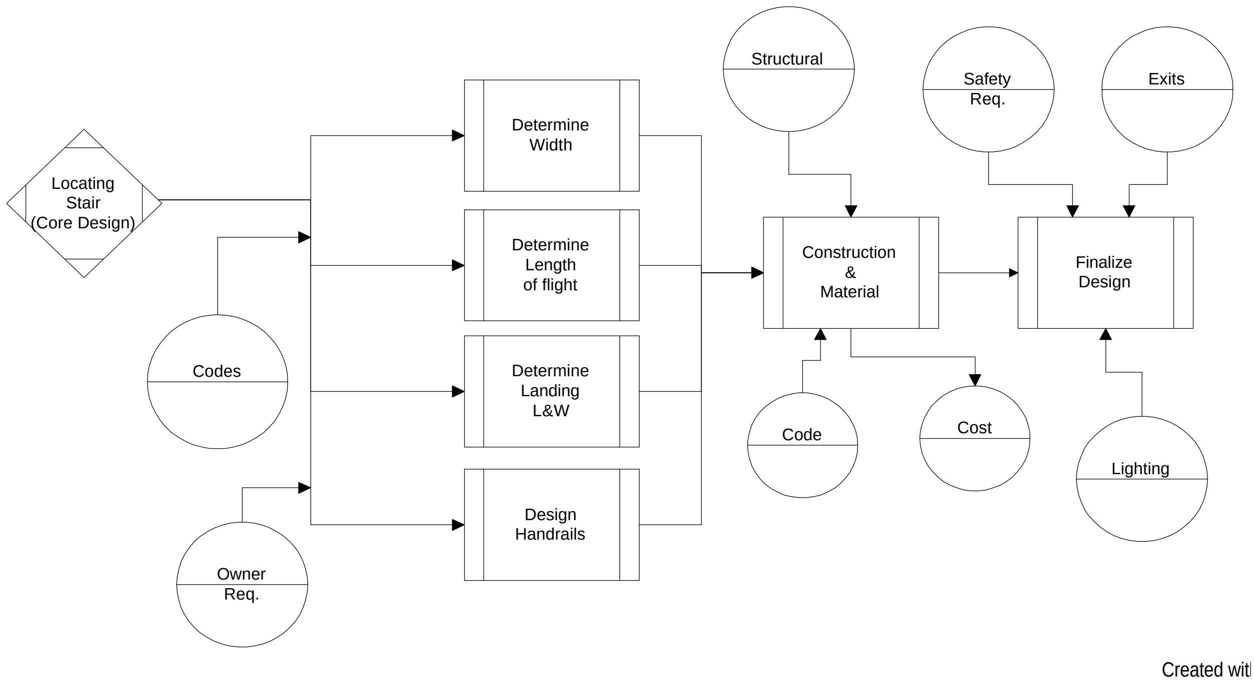
References:

- Safe haven documentation
- Calculation of stair rise and run

Contributors:

- project team

4.1.3.2. Process Diagram: Stair Design



4.1.3.3. Process Definition: Stair Design

4.1.3.3.1. Overview

The blocking and stacking process as an element of conceptual design begins after a building program is defined between the client and architect. The designer starts by creating graphic spaces according to the sizes defined in the building program. While reviewing the adjacency and space size, the spaces are moved around to determine their location horizontally on a floor in the building. The non-programmed spaces such as grouped core elements and circulation are added to the diagram. The process progresses when the vertical location of the space in the building (i.e. stacking is determined). The architect moves between the blocking and stacking tasks until the spaces are organized in an optimal manner. The building structural grid may be refined during this iterative stacking and blocking process.

4.1.3.3.2. Task 1 - Locate Stairs

Task Description:

Covered in this document under the Core design Process

4.1.3.3.3. Task 2 - Determine Width

Task Description:

The width of the stairs are determined by building codes which indicate the minimum sizes based on the number of occupants using the stairwell over a certain amount of time. The designer should take into consideration the depth of the handrail as it protrudes into the stair and cuts down on the actual width of the tread.

Example Usage Scenario:

None provided

4.1.3.3.4. Task 3 - Determine Tread and Risers

Task Description:

The length or run of the stairs is dependent on the height between the floors being calculated. There are appropriate height and depth of treads based on what is comfortable for occupants to walk up and down steps without stumbling. The rise/run of the stairs are defined in tables in local building codes.

Example Usage Scenario:

None provided

4.1.3.3.5. Task 4 - Determine Landing

Task Description:

The landing performs two functions. First it allows the occupants a place to exit out of a floor onto the stair well. The second function is that it is a location to change directions in the stair well. The landing width and depth is determined by stairs connected to the landing and the number of occupants switching between stair flights. The local building codes describe the appropriate size based on the occupants on each of the floors. A new requirement is the inclusion of a safe haven, which is an alcove on the stair landing where a wheel chair can reside out of the way of stair traffic until help can arrive.

Example Usage Scenario:

None provided

4.1.3.3.6. Task 5 - Guardrail design

Task Description:

None provided

Example Usage Scenario:

None provided

4.1.3.3.7. Task 6 - Handrail design

Task Description:

None provided

Example Usage Scenario:

None provided

4.1.3.3.8. Task 7 - Construction and Materials

Task Description:

As the design of the stair is taking shape, a decision on materials is made. The designer selects the material for the stairs such as concrete, steel, or a combination of both. The decision may be based on regional standards, ease of construction, or local fire codes. The materials on the tread and the type and construction of the nosing are also made at this point in the process. The final stage of deciding on the construction the designer determines how the stringer connects the tread, riser, and connects it to the stair well.

Example Usage Scenario:

None provided

4.1.3.3.9. Task 8 - Finalize Design

Task Description:

The final detail of stair design evolves other objects connected or part of the stair. This may include deciding on the type of exit doors, signage, standpipe location, location of vents and hatches. Also design of emergency lighting and ventilation should be performed by fire safety engineers at this point in the process.

Example Usage Scenario:

None provided

4.1.4. Process: Restroom Design

The design of restrooms involves effective movement of building occupants, ADA codes, and aesthetic use of materials. The minimum number of fixtures is determined by the number of occupants that reside on a floor or visit a floor.

4.1.4.1. Introduction

Overview:

At the start of restroom design, the number of fixtures are determined by the floor occupancy. The designer will also determine items such as partition type, fixture type, stall sizes, based on codes such as ADA and any client requirements. The next level of design involves locating the restroom fixtures and lavatories to use the most effective amount of space to contain cost but provide effective circulation. The next level of design involves locating the lavatories, mirrors, towel racks, grab bars, hand dryers, and any other object that services the restroom occupants. Appropriate location of fixtures and other items in the restroom may be determined by effective use of other building services such as plumbing stacks, etc. The final step of design is more aesthetic in that it involves the visual character of the restroom in selecting material type, sizes and objects such as faucets etc.

Process Scope:

- Commercial Public Restroom associated with the building core

Out-of-Scope:

- Locker Rooms, Showers.

Definitions:

- None defined

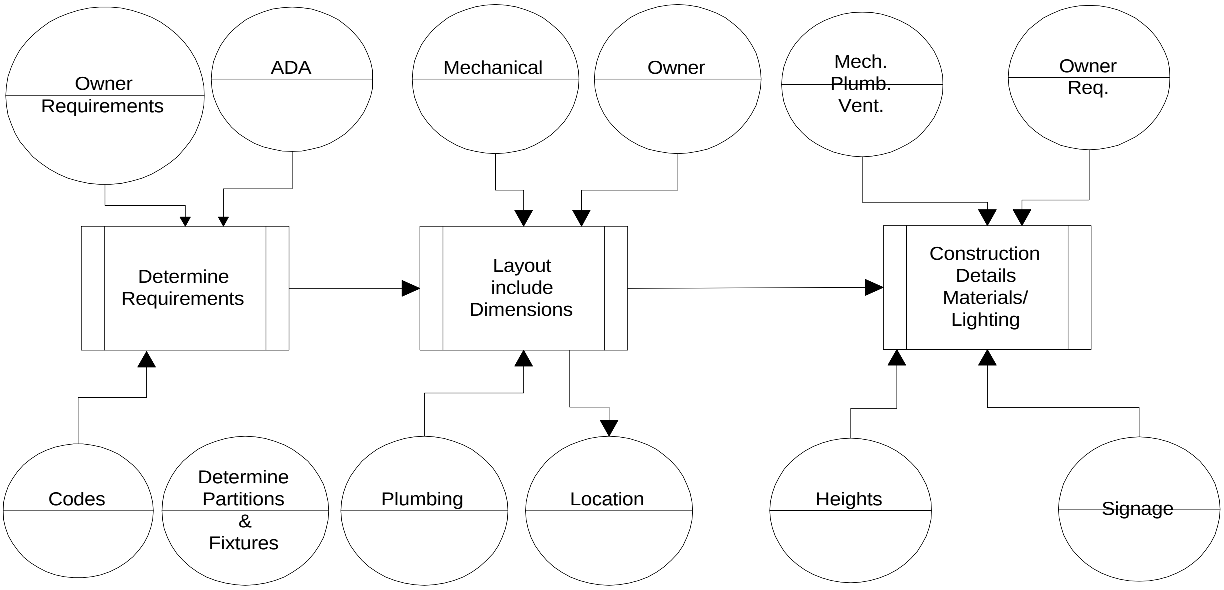
References:

- None defined

Contributors:

- project team

4.1.4.2. Process Diagram: Restroom Design



4.1.4.3. Process Definition: Restroom Design

4.1.4.3.1. Overview

None provided

4.1.4.3.2. Task 1 - Determine Requirements

Task Description:

The number of fixtures which is considered toilets, urinals and sinks is determined by codes and the floor occupancy. The ADA requirements define how many of the fixtures are designed for handicapped access.

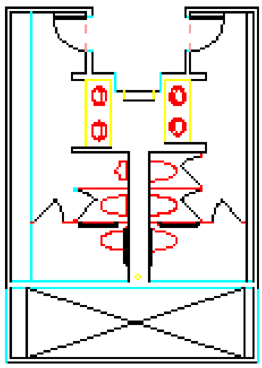
Example Usage Scenario:

None provided

4.1.4.3.3. Task 2 - Layout

Task Description:

Layout involves the location of the major fixtures and the stalls that surround them while creating appropriate circulation for occupants and handicapped. The effective delivery of services such as water and getting rid of waste will set a common plumbing wall which makes is cost effective by stacking all plumbing services for the building.



Example Usage Scenario:

None provided

4.1.4.3.4. Task 3 - Construction Detailing, Finishes and Lighting

Task Description:

hand dryers, trash receptacles, outlets, etc. A closer look at other trades, such as Plumbing, HVAC, and Electrical. The final step of the restroom design involves selecting the materials and lighting appropriate for the building type and clients' requirements. The selection of the style of partitions, faucets, and other fixtures such as whether the toilet is wall hanging or rests on the floor is based on the designer's preferences.

Example Usage Scenario:

None provided

4.1.5. Process: Roof Design

The process of roof design is a mixture of aesthetics, weather dissipation, and hiding other building objects such as telecommunications, mechanical, and elevators. The process is iterative, the designer works back and forth between the massing and roof design to create a building design which expresses a character appropriate to the area, client wishes, and building type.

4.1.5.1. Introduction

Overview:

The architect determines a type of roof based on the design direction and the character of the building. Using the building massing, the architect lays out the roof. On pitched roofs, refinement of the intersection of the roof planes will be necessary. The architect then determines and designs the drainage. The intersection of the roof with the elevations are designed and detailed. The layout and penetration of other services that are hosted on the roof are considered. Materials are selected.

Process Scope:

- Design inputs would cover the process of exterior and interior programs including eaves and overhangs. Interior issues need to address cathedral ceilings, dormers, etc. Exterior roof issues include steeples, parapet roof ventilation, electrical, drainage, recreational areas, planters, irrigation, window washing, skylights, smoke evacuators, access hatches, mechanical screens, roof walk pads, lighting control, and FAA lighting.

Out-of-Scope:

- Actual design of electrical, venting, access hatches, smoke evacuators, sidewalk protection canopies.

Definitions:

- Dormers (space projection from sloped roof, may be considered standard roof, not unique)
- Recreation areas
- Helipads
- Steeples can also be used as a screen or just ornate
- Screening
- Chimneys
- Vents
- Drainage
- Telecommunications: Transmission Tour

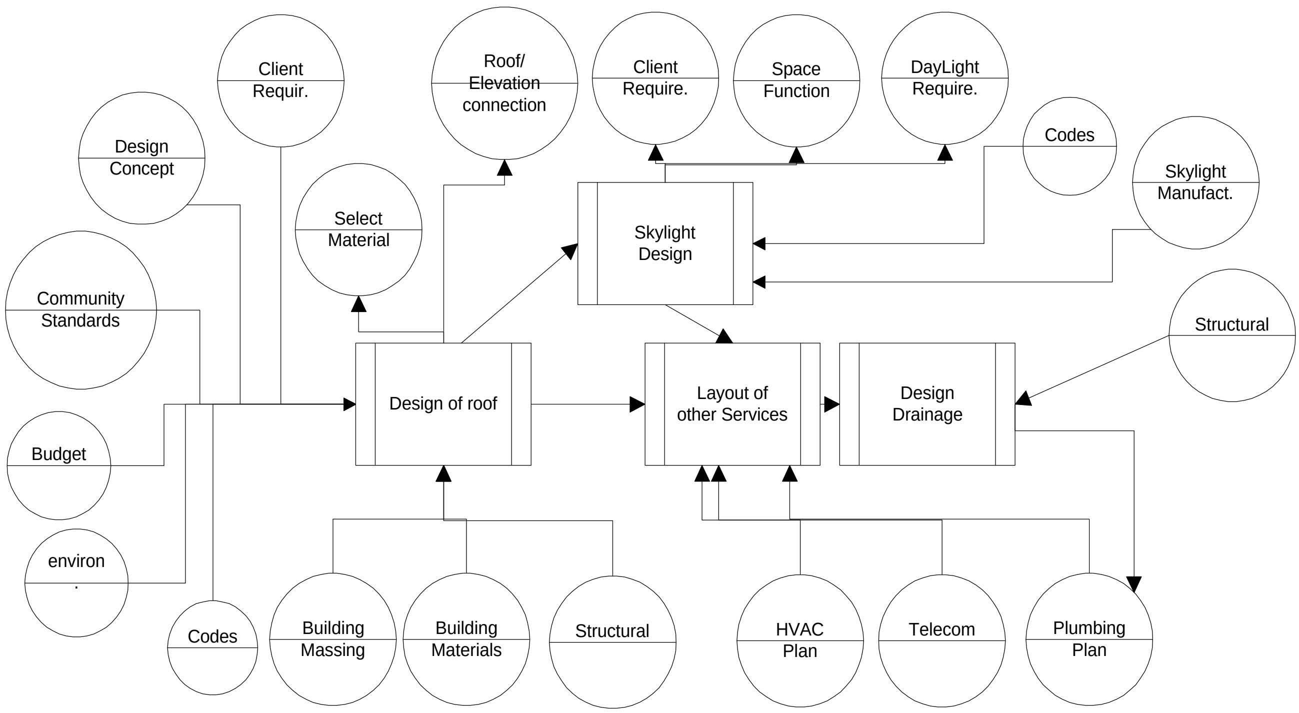
References:

- None defined

Contributors:

- project team

4.1.5.2. Process Diagram: Roof Design

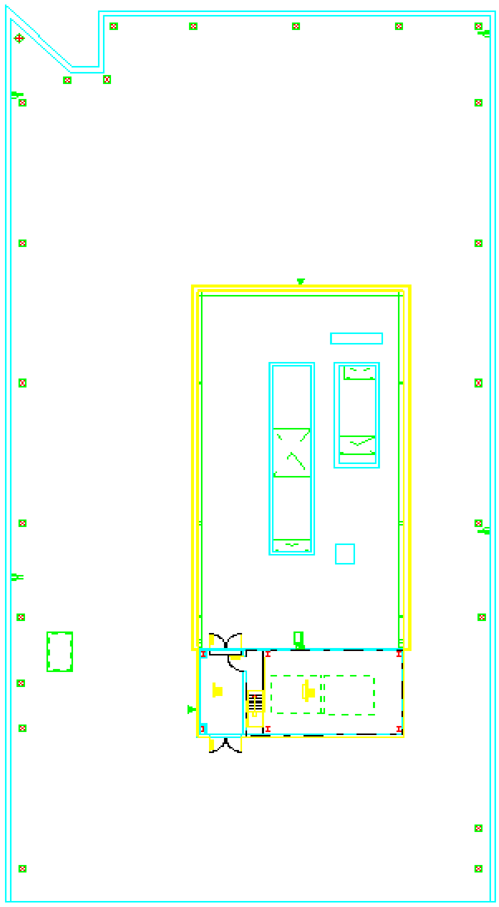


4.1.5.3. Process Definition: Roof Design

4.1.5.3.1. Overview

None provided

4.1.5.3.2. Task 1 - Design Roof



Task Description:

The determination of roof type is a balance between form and function of the building. The decision on style or shape of the roof is a combination of styles of the neighbor buildings along with the desire of the client. The roof type refers to flat, pitched, gabled, etc. An understanding of the types of services supported by the roof may determine the type of roof selected. The regional climate may dictate a shape of the roof structure to support the amount of wind, precipitation, snow, and also radiation of heat from the sun. After the selection of the roof type, a preliminary design is produced to determine the actual shape and its impact on the building form. The slopes of the roof elements to provide the correct shedding of the climatic element will determine pitches. The changes in the massing elements will force the roof to change as new building masses intersect each other. The function of the spaces below the roof may determine the shape along with the need to enclose building services. The type of material used will have a direct impact into the shape of the roof depending on the material constructability. Finally the surrounding building roof-scapes may dictate a direction for the shape.

Example Usage Scenario:

None provided

4.1.5.3.3. Task 2 - Skylight/Clear Story

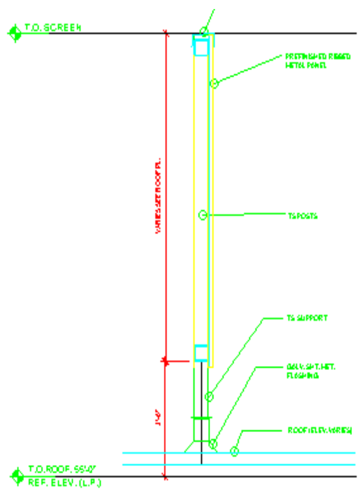
Task Description:

After the shape is created, the integration of any skylights or clear story windows will be integrated into the roof to evaluate the impact and location based on preliminary structural needs. A skylight may not be as simple as a pre-manufactured domed square skylight but could be a complicated barrel vault that runs the length of the building. The intersection of the skylight with the roof becomes critical and may force certain decisions on pitches of roof plains to direct the outside elements away from the glass area.

Example Usage Scenario:

None provided

4.1.5.3.4. Task 3 - Layout of Services



Task Description:

With the major roof shape determined and items such as skylights, etc. placed, the designer then looks at the projections through the roof of items such as vents, stair/elevator, telecommunications, glass cleaning, and mechanical. Depending on the size of the projection techniques such as providing screens and other methods to hide the services may be required. Depending on the building program areas such as heliports, health and fitness, and walkways my be required to be included in the roof design.

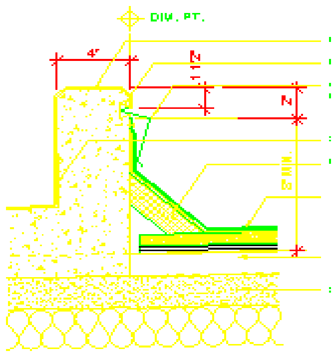
Example Usage Scenario:

None provided

4.1.5.3.5. Task 4 - Design Rain/Snow Drainage

Task Description:

At this point, after the building services are located the shedding of water needs to be addressed. The runoff of water is calculated based on the roof planes and slopes and a design concept is created to use roof drains, scuppers, or gutters to empty the water from the roof. The weather (water, snow, heat) are the major cause of roof failure. Details are created to communicate how to keep moisture out of the building and delineate the intersection of materials at joints.



Example Usage Scenario:

None provided

4.2. [AR-2] Compartmentation of Buildings

Processes Defined in this project:

1. Compartmentation of buildings

4.2.1. Process: Compartmentation of buildings

4.2.1.1. Introduction

Overview:

The overall process is split into two stages as defined below:

Stage 1 is concerned with limiting the spread of fire and smoke within the building.

- The building is sub-divided into compartments, enclosed by fire resisting construction.

The building can be sub-divided into compartments by any or all of the following constraints:

- Main Uses
- Spaces occupied by individual owners and/or tenants
- Regulatory geometrical limits set on floor area or space volume.

Stage 2 is concerned with providing a satisfactory means of escape from a building or part of a building to a place of safety.

- By providing enough Escape Routes of the correct capacity, and which are adequately lit and suitably located.

  A satisfactory Means of Escape is provided by ensuring :

  - *There is an adequate number of exits, to serve a known number of occupants, within a Space, Compartment or Storey.*
  - *There are enough Escape Routes of adequate capacity within a Space, Compartment or Storey, to serve all the occupants, likely to use the route in the event of fire.*
  - *That, if any Space, Compartment or Storey is likely to render any Escape Route unusable due to the emission of smoke, then either, smoke seals to exit doors, or a pressurized lobby to control the passage of smoke are provided.*
  - *That Escape Routes are adequately spaced to limit the travel distance to the nearest exit.*
  - *That Escape Routes are adequateley lit by means of an independent power supply.*

This IFC R2 project will focus on Stage 1 -- the process for identifying fire compartments and the fire protection at their notional boundaries, in order to limit the spread of fire and smoke within the building.

Process Scope:
- None provided

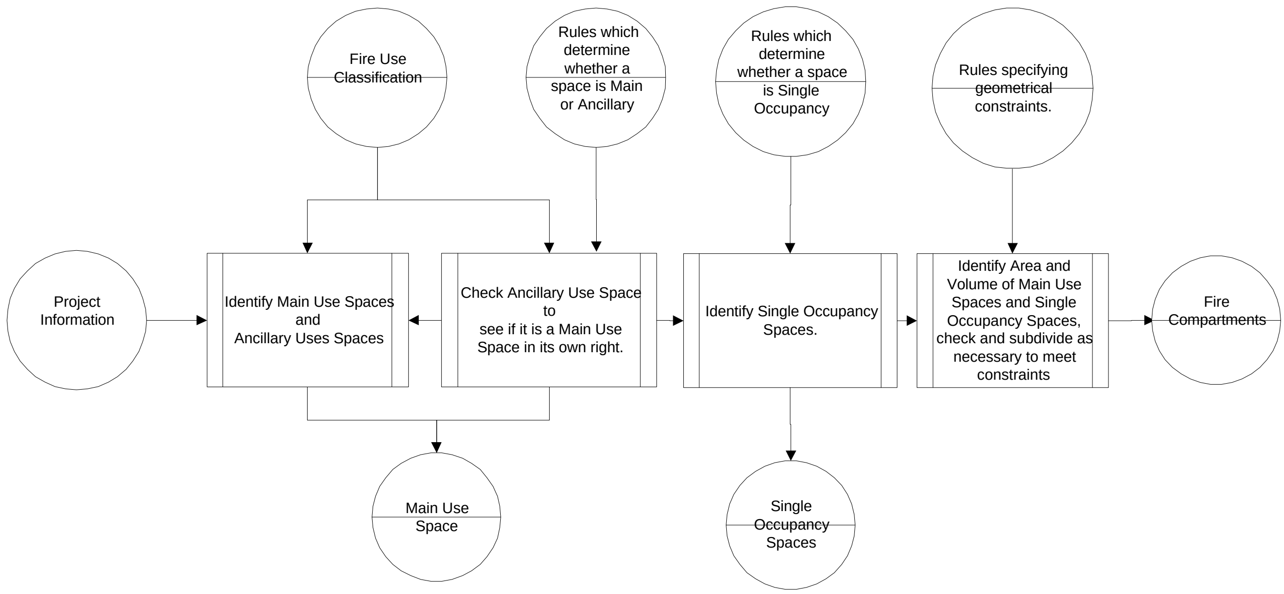
Out-of-Scope:
- Fire Protection to Elements of structure.
- Fire Protection to Electrical, Mechanical and Plumbing Services.
- Fire Fighting Equipment
- Fire Resistance and Surface Spread of Flame
- Interrelationship with adjoining buildings and to the boundary.

Definitions:
- **Fire Use Classification:** classification listing the different possible uses of a building or space for the purposes of fire compartmentation
- **Fire Use:** A member of a Fire Use Classification.
- **Main Use Space:** Is a building or part of a building considered significant for Fire Compartmentation.
- **Ancillary Use Space:** Is a part of a building which supports a Main Use and which is not considered significant for Fire Compartmentation. An Ancillary Use may be considered a Main Use in its own right if it meets certain criteria.
- **Fire Compartment:** A building, or part, comprising one or more spaces constructed so as to prevent the spread of fire to or from another part of the same or adjoining buildings and which meets the area, volume, or occupancy limits set by Statutory Requirement.
- **Single Occupancy Space:** A space possessed and used by only one person or organisation.
- **Height Above Grade:** Height of floor of top storey of Fire Compartment above accessible horizontal surface external to the Fire Compartment.
- **IsSprinklered:** The building is filled throughout with an automatic sprinkler system.

References:
- Building Regulations 1991. Approved Document B: Fire Safety.
- Uniclass classification.
- Ci/SfB classification - space classification.
- British Standards.

Contributors:
- Project Team (see project summary)

4.2.1.2. Process Diagram: Compartmentation of buildings



4.2.1.3. Process Definition: Compartmentation of buildings

4.2.1.3.1. Overview

It is assumed that the fire usually starts in one place, and spreads to other parts of the building. In order to allow the occupants of the building to escape, the first priority is to stop the spread of fire and smoke to other parts of the building, as well as to maintain common escape routes free of fire and smoke. Compartmentation controls fire within a limited space, allowing occupants of the building to escape from the seat of the fire to a place of safety.

Note: Tasks A through D are repeated for each building storey.

4.2.1.3.2. Task A - Identify Main/Ancillary Use Spaces

Task Description:

For each building identify the Main Use Spaces and Ancillary Use Spaces.

Example Usage Scenario:

None provided

4.2.1.3.3. Task B - Adjust Main/Ancillary Use Spaces according to Code

Task Description:

Analyse the Ancillary Use Spaces with reference to regulations to see if they need to be treated as Main Use Spaces in their own right. If not subsume Ancillary Use Spaces into their corresponding Main Use Spaces.

Example Usage Scenario:

None provided

4.2.1.3.4. Task C - Identify Single Occupancy Spaces

Task Description:

For each building identify all the Single Occupancy Spaces contained within the building.

Example Usage Scenario:

None provided

4.2.1.3.5. Task D - Check Areas/Volumes to Design Fire Compartments

Task Description:

Specify the boundaries of Main Use Spaces and Single Occupancy Spaces as Fire Compartment boundaries.

Analyse the Fire Compartments defined by the boundaries specified in task C. For each compartment check the regulations governing the maximum dimensions for the Fire Use into which its use is classified. Subdivide each Fire Compartment as necessary in order to meet the rules. NB. the maximum allowable dimensions of a Fire Compartment are likely to also depend on whether or not the building in which the compartment is located is sprinklered and on the height above grade of the top floor of the building in which the Fire Compartment is located.

Example Usage Scenario:

None provided

4.3. [BS-1] HVAC System Design

Processes Defined in this project:

1. HVAC Duct System Design
2. HVAC Piping System Design

4.3.1. Process: HVAC Duct System Design

4.3.1.1. Introduction

Overview:

See Project summary.

Process Scope:

- Select and locate components to be connected in the duct system
- Connect components with ducts and fittings
- Locate other system components: dampers, etc.
- Facilitate sizing ducts and fittings
- Facilitate interference checking
- Facilitate pressure loss calculations
- Facilitate fan selection
- Generate final system representation

Out-of-Scope:

- Selection of system type and system configuration
- Actual sizing the duct and fittings
- Performing interference checks
- Performing pressure loss calculations
- Performing fan selection

Definitions:

- ASHRAE - American Society of Heating Refrigeration and Air Conditioning Engineers
- SMACNA - Sheet Metal and Air Conditioning Contractor's National Association
- BACnet – Building Automation and Control Network

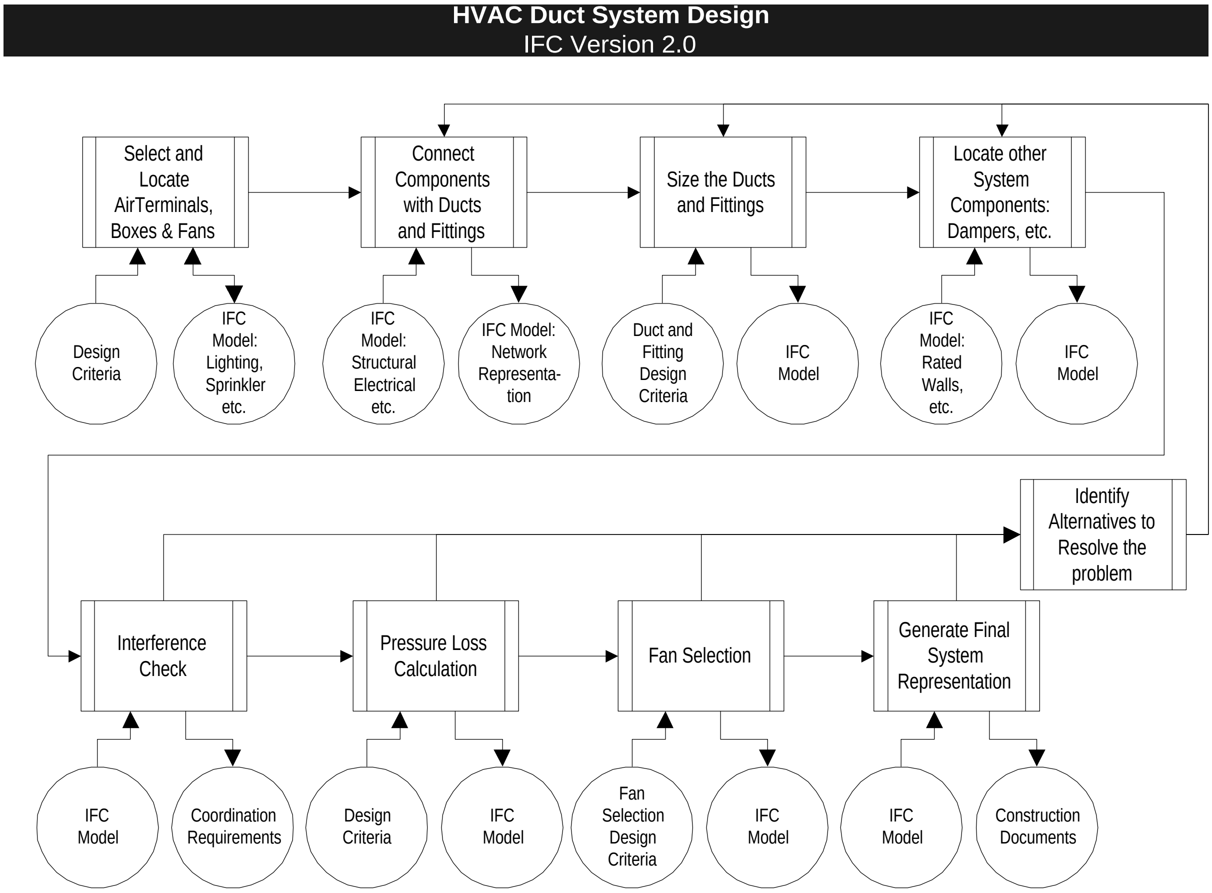
References:

- ASHRAE Handbooks
- SMACNA HVAC Duct Construction Standards
- BACnet Specifications (ANSI/ASHRAE 135-1995)
- IFC R2.0 BS-3 Project: Pathway Design and Coordination

Contributors:

- James Forester, North American Chapter: Technical Coordinator
- North American Chapter -- Building Services Committee
- United Kingdom Chapter -- Building Services Committee
- German Chapter -- HVAC Committee
- Nordic Chapter -- HVAC Committee
- French Chapter -- HVAC Committee

4.3.1.2. Process Diagram: HVAC Duct System Design



4.3.1.3. Process Definition: HVAC Duct System Design

4.3.1.3.1. Overview

Once an appropriate system type has been determined (outside of scope), the HVAC Duct System Design process begins by selecting and locating air terminal devices, air terminal boxes and fans that will be part of the system. Reflected ceiling plans may be available showing light fixtures, sprinklers and the ceiling grid to aid in the location of air terminal devices. If these are not available the engineer selects locations for the air terminal devices and submits the locations to other members of the design team for coordination. To appropriately locate the air terminal boxes and devices, structural information is required so that initial interferences may be avoided.

The next step is to connect the air terminals, terminal boxes and fans together with ducts and fittings. A network representation of this system layout is typically generated for use in calculating duct sizes and a graphical representation is generated for coordination with other disciplines.

The room air flow rates are then assigned to the air terminals. These air flow rates are determined by the building cooling and heating load calculations; these processes are defined in the IFC 1.0 Specifications.

The duct and fitting sizes are then calculated based upon these air flow rates and the duct system design criteria. The duct and fitting sizes are then updated in the graphical representation of the system.

Other required system components (i.e., dampers, sensors, etc.) are then located on the graphical representation. This process requires various architectural information such as the locations of fire rated walls, exit corridors, etc., which are available from the architectural plans. Any components that require other disciplines to respond are identified, such as electrical power required to fan powered terminal boxes.

Once these components are located, an interference check is performed. This requires the coordination with the other building disciplines and may require resizing or relocating ducts, fittings, etc.

A final duct system pressure loss calculation may be required beyond that made during the duct sizing based on changes from estimated values to actual values that can only be determined after the duct sizes are finalized. With the final pressure loss, the total air flow and the engineering design criteria, a fan can be selected.

Primary difficulties in the duct system design process are coordination with other disciplines to prevent conflicts for space and to predict sound levels that result from air flow in the ducts and air terminals.

4.3.1.3.2. Task A - Select and Locate System Components

Task Description:

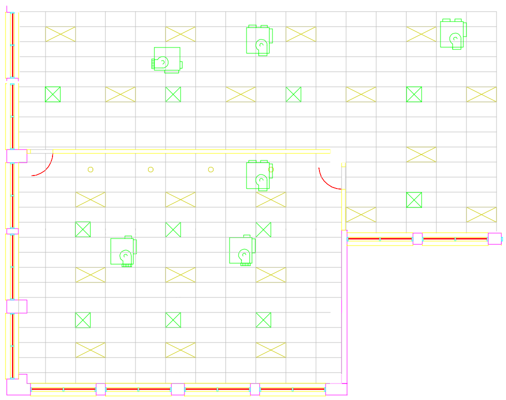
Before the engineer can select and locate system components, the following information is required from other members of the design team:

- Ceiling grid plans (architect)
- Reflected ceiling plans (architect)
- Lighting plans (architect or lighting designer)
- Structural plans (structural engineer)
- Plumbing plans (plumbing engineer)
- Piping plans (HVAC engineer)
- Sprinkler plans (fire protection engineer)
- Smoke detector plans (fire protection engineer)
- Speaker plans (architect or electrical engineer)

With the above information, the engineer can perform the tasks required for this process. If some of the above information is unavailable, the engineer must either generate it manually or make assumptions based on the function and usage of the spaces involved in the design.

Generally there are three types of system components to be selected and located for this process:

- **Fan(s):** The location of the fan(s) used for moving the air in the duct system. The fan(s) may be for supplying, returning or exhausting air from the building or space. The fan(s) may be stand alone or part of a manufactured assembly, which may include coils, filters, mixing boxes, etc. Combination fans, coils etc. may be factory assembled or assembled at the project site. The exact size and capacity of the fan(s) are not required at this stage, though an approximate fan size is necessary to ensure the space selected for the fan is adequate. Though not essential, having the size of the fan outlet is useful in sizing the transition between the fan outlet and the duct.



- **Air Terminal Boxes:** Depending on the type of HVAC system, the system may or may not have air terminal boxes. Terminal boxes are typically located in a branch duct downstream from the main supply duct. There are several different types of terminal boxes. They are used in various ways to control the amount and or temperature of the air being supplied to one or more spaces with similar heating and cooling load characteristics. It is desirable but not necessary to know the exact terminal boxes being used in order to size the associated ducts. If the exact terminal box being used is known, the exact duct connection size and pressure loss through the terminal boxes are known. Also terminal boxes from different manufactures have different dimensions and knowing the exact dimensions and clearances required for maintenance can prevent future conflicts for space.

  Terminal boxes are typically located after the air terminal devices used for distributing the air in the spaces are located. This allows the terminal boxes to be positioned to permit the shortest duct runs between the terminal box and the air terminal devices it supplies.

- **Air Terminal Devices:** Air terminal devices are used to distribute the air from the duct system to the spaces or to remove air from the spaces. The air terminal device can be connected to the supply, return or exhaust air ducts in different ways:

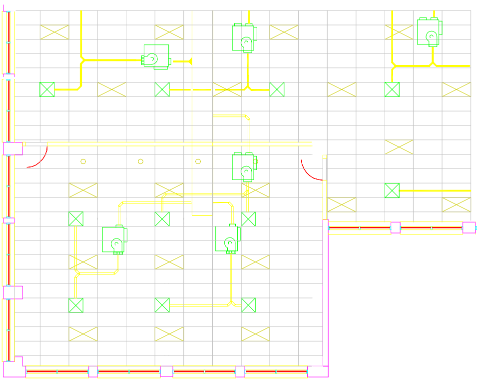
- Directly into the side of a main or branch duct or on a short duct section that allows for a volume damper and/or a lower resistant transition from the duct to the air terminal device. This type of connection is used where the duct is exposed in the space.
- Directly on the outlet of a terminal box.
- On the end of a branch duct from the main duct or from a duct on a terminal box. The air terminal device may terminate in an opening in a ceiling or wall, or be exposed entirely in the space.
- An air terminal device can simply be located within an opening through a wall that forms a chase that is part of the general building construction or to an above ceiling plenum used for transferring return air. Locating an air terminal devices used in this way are not required for sizing the duct system, although they are usually located at the same time other air terminal devices are located.
- Selecting the exact air terminal devices and their accessories at this stage is not required to size the duct system but is desirable to keep from revisiting each of the air terminal devices a second time. Making a selection also supplies the exact duct connection required and the exact pressure loss through the air terminal device which is necessary in the final design of the duct system for the fan selection.

Example Usage Scenario:

None provided

4.3.1.3.3. Task B - Connect Components with Ducts and Fittings

Task Description:



Before the engineer can connect air terminals, boxes and fans with ducts and fittings, the following information is required from other members of the design team:

- Floor plans (architect)
- Structural plans (structural engineer)
- Coordination requirements from any other disciplines

This step involves preparing drawings that schematically represent the system under design. The duct is typically drawn from the fan to the air terminal boxes, if any, and then to the air terminal devices. Various types of elbows, tees and other fittings are utilized so each fitting must be designated as to what type is being used. These schematics are then used to begin coordination with other disciplines which are impacted by the duct system. The information derived from the air flow associated with each air terminal device together with the schematic drawing is used by a duct sizing program to determine actual duct sizes. Often the duct connections to different types of equipment are standardized.

Example Usage Scenario:

None provided

4.3.1.3.4. Task C - Sizing the Duct and Fittings

Task Description:

The ducts are sized using the information derived from the schematic drawings and the design criteria established by the engineer. Design criteria include such information as type of design (constant pressure, static regain, etc.), maximum velocity, maximum height of duct, material to be used, etc. The actual methodologies and algorithms used for sizing of the duct and fittings is out of scope, as this is application specific.

Example Usage Scenario:

None provided

4.3.1.3.5. Task D - Locate Other System Components

Task Description:

The location of other duct system components is determined from information in the schematic drawings and the design criteria established by the engineer. Other components, such as fire dampers, volume control dampers, louvers, filters, etc., are then located on the drawing. These components have pressure losses that may only be precisely determined after the actual duct sizes are known. After these pressure losses are determined, the total pressure loss is calculated. In many cases the pressure loss for these components are known before the ducts are sized or can be closely estimated so they can be entered before sizing the ducts and fittings.

Control elements, such as sensors, actuators and controllers, can also be specified at this point. The design engineer typically defines the general parameters of a control device. However, a control system vendor may utilize many different mechanisms to achieve the desired effect intended by the design engineer. For this reason, only a subset of control element information is necessary.

Example Usage Scenario:

None provided

4.3.1.3.6. Task E - Interference Check

Task Description:

Before the engineer can perform an interference check, the following information is required from other members of the design team:

- Floor plans (architect)
- Ceiling grid plans (architect)
- Reflected ceiling and/or lighting plans (architect or lighting designer)
- Power plans (electrical engineer)
- Piping plans (HVAC engineer)
- Plumbing and sprinkler plans (plumbing or fire protection engineer)
- Structural plans (structural engineer)
- Coordination requirements from any other disciplines

Interference checking identifies where changes are required in the location or size of specific ducts in order to eliminate physical conflicts with other building components or systems. An example scenario could be that the height of a duct is too great, thus requiring a transition fitting to clear a beam or a pipe. After any interferences are corrected, the total pressure loss for the system can be calculated. Performing the actual interference check is out of scope, as this is application specific.

Refer also to the IFC R2.0 BS-3 Project: Pathway Design and Coordination.

Example Usage Scenario:

None provided

4.3.1.3.7. Task F - Identify alternatives to design problems

Task Description:

This step requires the designer to go back and redesign certain portions of the system. This may involve regenerating the schematic design documents and recalculating system component sizes. Note that this step may occur at any point in the process.

Example Usage Scenario:

None provided

4.3.1.3.8. Task G - Pressure Loss Calculations

Task Description:

After any interference conflicts are corrected the total pressure loss for the system can be calculated. This information is essential to properly select a fan that will serve the duct system. Performing the actual pressure loss calculations is out of scope, as this is application specific. Systems that employ multiple fan systems, such as those using fan-powered terminal boxes, must be appropriately modeled by the application software to accommodate this scenario.

Example Usage Scenario:

None provided

4.3.1.3.9. Task H - Fan Selection

Task Description:

With the total air flow and pressure requirements (as determined in the preceding steps), in coordination with the engineering design criteria for the fan (i.e., class, type of fan, materials for housing and wheel or blades, etc.), a specific fan may be selected to serve the duct system. Of particular concern regarding fan selection is the acoustical performance of the fan. After all of the fan criteria are established the actual fan selection is typically made using a fan manufacturer’s fan selection program. Performing the actual fan selection is out of scope, as this is application specific.

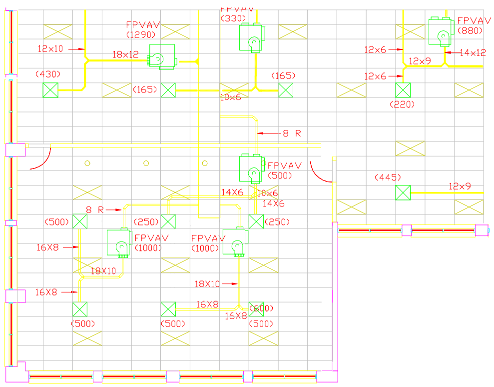
Example Usage Scenario:

None provided

4.3.1.3.10. Task I - Generate Final System Representation

Task Description:

After the components are selected and the duct and fittings are sized the results are used to generate graphical representations showing the actual size and location of the ducts and all of the associated components.



Example Usage Scenario:

None provided

4.3.2. Process: HVAC Piping System Design

4.3.2.1. Introduction

Overview:

See project summary.

Process Scope:

- Select and locate components to be connected in the piping system
- Connect components with pipe and fittings
- Locate other components: strainers, valves, etc.

- Facilitate sizing pipes and fittings
- Facilitate interference checking
- Facilitate pressure drop calculations
- Facilitate pump selection
- Facilitate flow analysis
- Generate final system representation

Out-of-Scope:

- Selection of system type
- Actual sizing the pipe and fittings
- Performing interference checks
- Performing pressure drop calculations
- Performing pump selection
- Performing flow analysis

Definitions:

- ASHRAE - American Society of Heating Refrigeration and Air Conditioning Engineers
- BACnet – Building Automation and Control Network

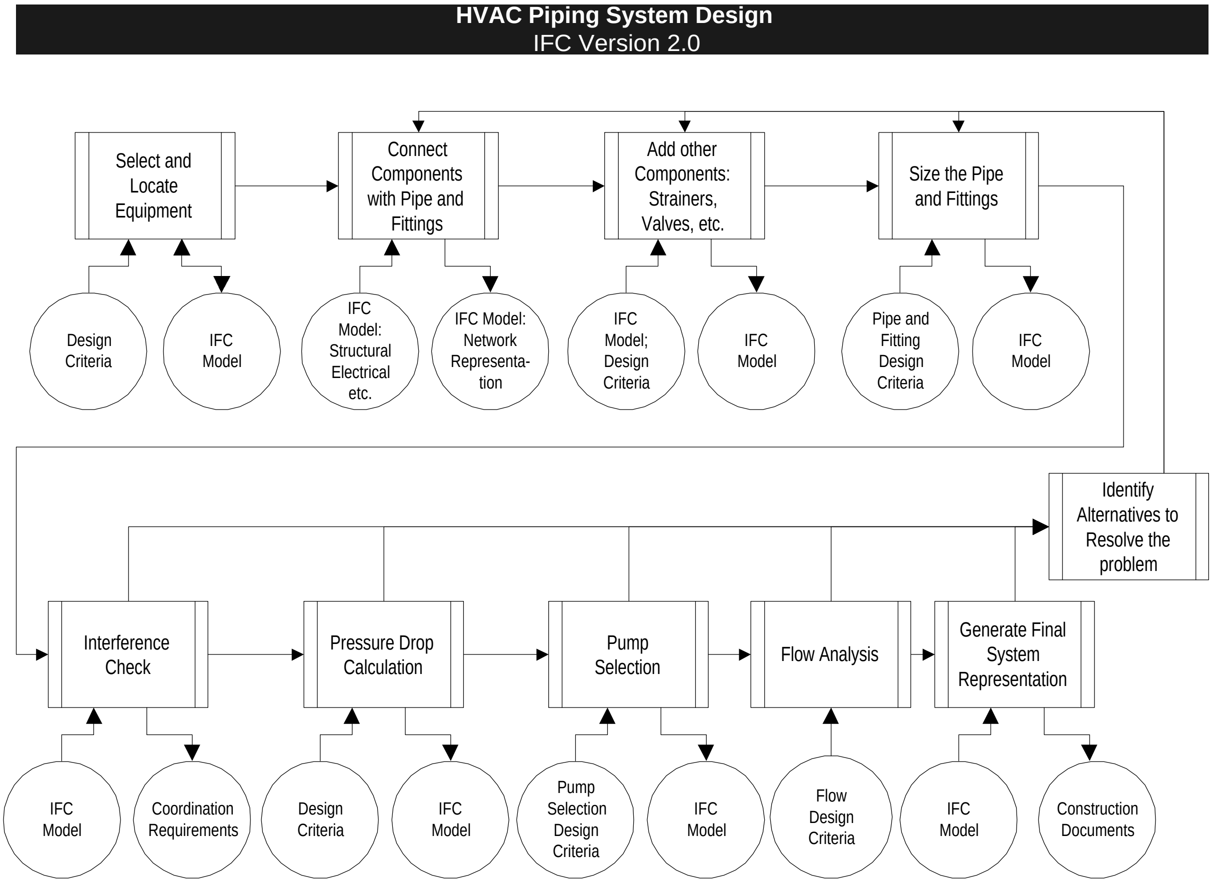
References:

- ASHRAE Handbooks
- BACnet Specifications (ANSI/ASHRAE 135-1995)
- IFC R2.0 BS-3 Project: Pathway Design and Coordination

Contributors:

- James Forester, North American Chapter: Technical Coordinator
- North American Chapter -- Building Services Committee
- United Kingdom Chapter -- Building Services Committee
- German Chapter -- HVAC Committee
- Nordic Chapter -- HVAC Committee
- French Chapter -- HVAC Committee

4.3.2.2. Process Diagram: HVAC Piping System Design



4.3.2.3. Process Definition: HVAC Piping System Design

4.3.2.3.1. Overview

Once an appropriate system type (chilled water, hot water, condenser water, etc.) has been determined (outside of scope), the Piping System Design process begins by selecting and locating pumps, coils, chillers, boilers, heat exchangers, cooling towers, etc., that will be part of the system. To appropriately locate the equipment, architectural and structural information is required so that initial interferences may be avoided.

The next step is to connect the various pieces of equipment together with pipes and fittings, including specifying the types of fittings (i.e., 90 degree elbow, 90 degree long-radius elbow, 45 degree elbow, thru tee, etc.). A graphical representation of this system layout is generated for use in calculating pipe sizes and coordination with other disciplines.

The fluid flow rates, fluid temperature changes, and pressure drops are assigned to the coils, heat exchangers, or other pieces of equipment that remove or add heat or power from the system. The fluid flow rates are determined from the building cooling and heating load calculations (defined in the IFC 1.0 Specifications), the engineer’s design criteria, or from specific equipment requirements.

The pipe and fitting sizes will then be calculated based upon these fluid flow rates and the pipe system design criteria. The pipe and fitting sizes are then reflected in the graphical representation of the system.

Other required system components, such as valves, strainers, etc., are then located on the graphical representation. Any components that require other disciplines to respond are identified, such as electrical or pneumatic power required to operate control valves.

Once these components are located, an interference check is performed. This requires spatial coordination with other building disciplines and may require some pipes to be relocated.

A pressure drop calculation is then performed to determine the system pressure drop. With this information as well as the total fluid flow rate and the engineering design criteria, a pump can be selected.

Primary difficulties in the pipe system design process are coordination with other disciplines to prevent conflicts for space job and to predict sound levels which result from rotating equipment and fluid flow in pipes.

4.3.2.3.2. Task A - Select and Locate System Components

Task Description:

Before the engineer can select and locate system components, the following information is required from other members of the design team:

- Floor plans (architect)
- Reflected ceiling plans (architect)
- Structural plans (structural engineer)
- Duct plans (HVAC engineer)
- Plumbing plans (Plumbing engineer)
- Pipe system design criteria (HVAC engineer)

The selection of equipment (coils, evaporators, condensers, unit heater, radiation, etc.) the piping system will serve is made by the designer, using information from the heating and cooling load calculations in conjunction with manufacturers' equipment information and engineering judgment. The selection of equipment should include the type and size of pipe connections to the equipment. The physical location of the equipment is then determined, giving consideration to space requirements for maintenance and removal of coils and tube bundles.

Example Usage Scenario:

None provided

4.3.2.3.3. Task B - Connect the Components with Pipe and Fittings

Task Description:

Before the engineer can connect equipment with pipes and fittings, the following information is required from other members of the design team:

- Floor plans (architect)
- Structural plans (structural engineer)
- Coordination requirements from any other disciplines

This step involves preparing a schematic representation of the system under design. The various types of elbows, tees and other fittings that are utilized must be designated as to what type is being used and its pressure drop characteristics. These schematic representations are then used to begin coordination with other disciplines that are impacted by the piping system. Interferences must include pipe hangers and supports, and insulation when applicable. Often the piping connections to a given type of coil, unit heater or other piece of equipment are standardized. These assemblies of pipe, valves, fittings, etc., can be treated as standardized piping templates for the given piece of equipment.

Example Usage Scenario:

None provided

4.3.2.3.4. Task C - Locate Other System Components

Task Description:

The locations of other piping system components (i.e., valves, strainers, etc.) are determined from information in the schematic drawings and the design criteria established by the engineer. These components have pressure drops, and connections that may be different from the pipe size. The requirement for some or all of these components may come from equipment selection programs, from standard lists or libraries, or be determined manually by the engineer.

Control elements, such as sensors, actuators and controllers, can also be specified at this point. The design engineer typically defines the general parameters of a control device. However, a control system vendor may utilize many different mechanisms to achieve the desired effect intended by the design engineer. For this reason, only a subset of control element information is necessary.

Example Usage Scenario:

None provided

4.3.2.3.5. Task D - Sizing the Pipe and Fittings

Task Description:

The pipe and fittings are sized using the information derived from the schematic drawing and the design criteria established by the engineer. Design criteria include such things as maximum velocity, pipe material to be used, etc. The actual sizing of the pipe and fittings is out of scope, as this is application specific.

Example Usage Scenario:

None provided

4.3.2.3.6. Task E - Interference Check

Task Description:

Before the engineer can perform an interference check, the following information is required from other members of the design team:

- Floor plans (architect)
- Ceiling grid plans (architect)
- Reflected ceiling and/or lighting plans (architect or lighting designer)
- Power plans (electrical engineer)
- Duct plans (HVAC engineer)
- Plumbing and sprinkler plans (plumbing or fire protection engineer)
- Structural plans (structural engineer)
- Coordination requirements from any other disciplines

Interference checking identifies locations where changes are required in the location of pipes in order to eliminate physical conflicts with other building components or systems. Interference checking must account for insulation, pipe supports and operating and servicing of valves, strainers, etc. For example, placing valves with stems down is not good engineering practice, while a horizontal stem requires more space for the stem, and a vertical stem may require more space at the side for service access. Performing the actual interference check is out of scope, as this is application specific.

Refer also to the IFC R2.0 BS-3 Project: Pathway Design and Coordination.

Example Usage Scenario:

None provided

4.3.2.3.7. Task F - Identify alternatives to design problems

Task Description:

This step requires the designer to go back and redesign certain portions of the system. This may involve regenerating the schematic design documents and recalculating system component sizes. Note that this step may occur at any point in the process.

Example Usage Scenario:

None provided

4.3.2.3.8. Task G - Pressure Drop Calculations

Task Description:

After interference conflicts are corrected the total pressure drop for the system can be calculated. This information is essential to properly select a pump that will serve the piping system. Performing the actual pressure drop calculation is out of scope, as this is application specific.

Example Usage Scenario:

None provided

4.3.2.3.9. Task H - Pump Selection

Task Description:

With the total fluid flow rates and pressure requirements (as determined in the preceding steps) in combination with the engineering design criteria for the pump (i.e., type of pump, pump materials, etc.), the pump selection can be made using a pump manufacturer's pump selection program. With the selection of the pump, consideration must be given to isolating the pump from the influence of expansion and contraction of the piping system due to temperature changes, and to the transfer of noise and vibration from the pump to the building. Performing the actual pump selection is out of scope, as this is application specific.

Example Usage Scenario:

None provided

4.3.2.3.10. Task I - Flow Analysis

Task Description:

For piping systems with diversified loads (so that all coils do not need maximum flow at the same time, or where there are multiple pumps in the system) the flow rates, pressure drops and temperatures may change randomly. Under these conditions good engineering practice requires further analysis of the flow. The results obtained from the pipe sizing program are necessary to the use of a flow analysis program. Performing the flow analysis is out of scope, as this is application specific.

Example Usage Scenario:

None provided

4.3.2.3.11. Task J - Generate Final System Representation

Task Description:

After the components are selected and the pipe and fittings sized, the results are used to generate graphical representations showing the actual size and location of the pipes, fittings and all of the components.

Example Usage Scenario:

None provided

4.4. [BS-3] Pathway Design and Coordination

Processes Defined in this project:

1. Coordination of mechanical systems
2. Coordination of mechanical systems within the building model

4.4.1. Process: Pathway Design and Coordination

4.4.1.1. Introduction

Overview:

The design of pathways contains the draft layout, the coordination and the representation of mechanical and electrical system-pathways to be installed.

This design process is carried out after the first coordination with the architect and structural engineers, and includes load estimates, energy and systems definitions required for a building.

The process ends with drawings containing the coordinated pathways for the mechanical and electrical installations (i.e. heating, cooling, air-conditioning, plumbing, fire-protection and electrical power) within a building.

The chapter on hand defines the prerequisites for the design of pathway based on generalized design of mechanical facilities.

Process Scope:

- Select and locate plant and other equipment to be connected to the system
- define pathway for different media (duct- and pipe work)
- coordinate pipe- and duct work within the pathway
- coordinate pathways within architectural and structural restraints

Out-of-Scope:

- None provided

Definitions:

- ISO
- DIN
- VDI
- SIA
- ASHRAE
- CIBSE

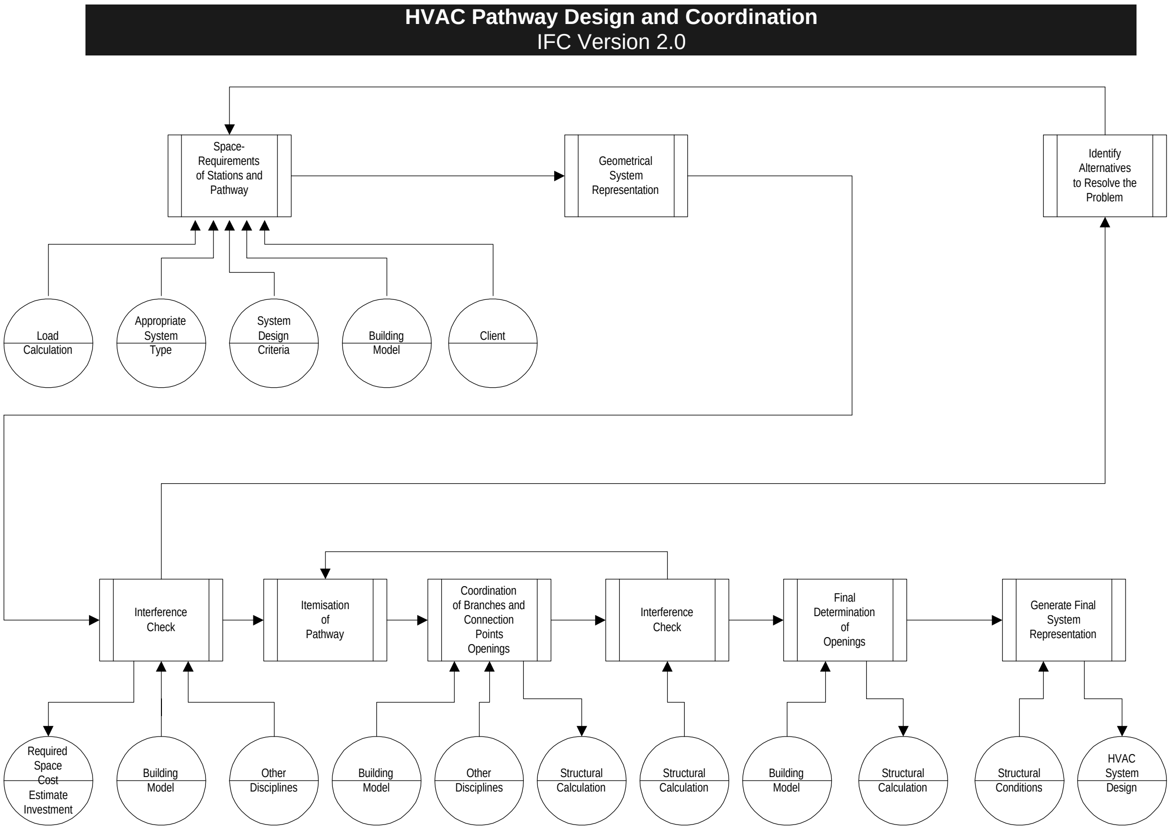
References:

- None provided

Contributors:

- Project Team (see project summary)

4.4.1.2. Process Diagram: Pathway Design and Coordination



4.4.1.3. Process Definition: Pathway Design and Coordination

4.4.1.3.1. Overview

Based on the building model and the conditions (program) defined by the customer, an initial estimate of required energy, technical equipment and systems is defined. The process of designing the pathway starts by defining the required spatial extents for technical equipment, piping, ducting and electrical routes.

A rough building layout by the architect will frequently be available showing the suggested locations for plant rooms and risers.

Considering these parameters, the engineer defines the necessary locations for plant areas and suggests the routing of the main pathways.

The required plant area and main pathways are represented in the M & E drawings.

This draft is presented to the architect/customer with details on space requirements (sections). Thereafter, a review of the suggested design solution will take place, taking into account the structure, the initial and future investment, user requirements, operating expenses and the flexibility achieved.

Parameters from the building model, the definition of systems and the routes of each media type can be combined to define the pathway. Air ducts, including equipment (fire dampers, VAV-boxes, etc.) are combined to form a ventilation pathway. Pipes for heating, cooling or plumbing are combined to form a media pathway. Electrical trays are combined to form an electrical pathway. Each pathway should allow variables for necessary insulation or fire proofing, as well as variables for necessary access for installation and maintenance. The optimization of the pathway itself can be done by varying the distance and position of ducts, pipes or trays. Every pathway must be coordinated within the architectural and structural restraints, as well as with each other.

A final definition of the spatial requirements for technical equipment and media distribution, defines the location of the pathway. The translation of the pathway into geometrical forms is carried out. These drawings serve as a guideline for the ongoing building services design.

The definitions of the structural systems (flat slab, concrete or steel construction, beams, etc.) reflect the location of the plant areas, risers and pathways. Collision detection with walls, slabs, binding beams etc. should be made and openings have to be defined.

4.4.1.3.2. Task A - Defining required space for stations

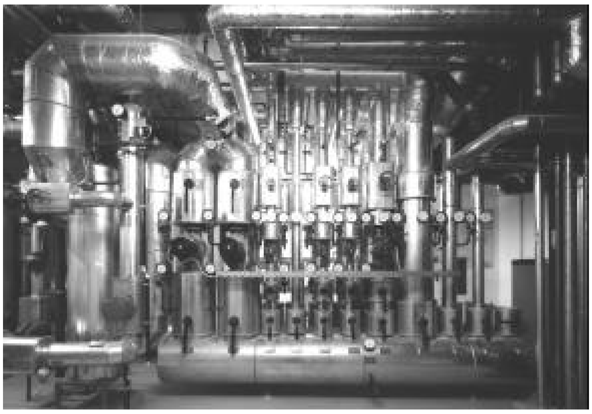
Task Description:

This step contains the dimensioning of main components for different systems, inquiry of the approximate space requirements and corresponding placing of the technical areas in the building model.

Example Usage Scenario:

None provided

4.4.1.3.3. Task B - Defining the required space for pathways



Task Description:

This step contains the dimensioning of the energy and media supply as well as the specification of the pathway.

Example Usage Scenario:

None provided

4.4.1.3.4. Task C - Geometrical representation of stations and pathways

Task Description:

This step contains the geometrical representation of the defined centralized media supply and pathway.

Example Usage Scenario:

None provided

4.4.1.3.5. Task D - Interference check

Task Description:

Collision detection within building services and building model.

Example Usage Scenario:

None provided

4.4.1.3.6. Task E - Identify alternatives to resolve the collisions

Task Description:

This step requires the designer amend and redesign certain portions of the system to resolve possible collisions. This may involve regenerating schematic design documents and recalculating system component and sizes. Note that this step may occur at any point in the process.

Example Usage Scenario:

None provided

4.4.1.3.7. Task F - Itemization of Pathway

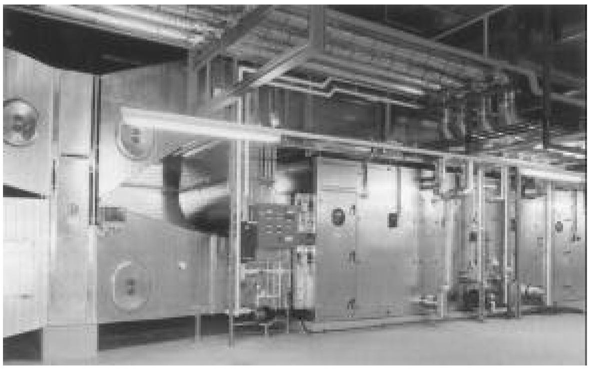
Task Description:

This step contains the detailed output of a pathway. Consideration of connection points and branches as well as placement and distance of each pipe or duct, the cross-sectional dimension of the pathway is brought into line with the respective conditions and will be optimized.

Example Usage Scenario:

None provided

4.4.1.3.8. Task G - Coordination of branches



Task Description:

This step contains the coordination of different trades within the design of pathway at branches as well as the coordination with structural conditions like binding beams etc.

Example Usage Scenario:

None provided

4.4.1.3.9. Task H - Interference check

Task Description:

Final collision detection within building services and building model.

Example Usage Scenario:

None provided

4.4.1.3.10. Task I - Determination of openings

Task Description:

This step contains the specification of openings defined by the itemized pathway or single pipes or ducts.

Example Usage Scenario:

None provided

4.4.1.3.11. Task J - Generate final system representation

Task Description:

This step takes us back to HVAC System Design.

Example Usage Scenario:

None provided

4.5. [BS-4] HVAC Loads Calculation

Processes Defined in this project:

2. Building Heating and Cooling Load Calculation

4.5.1. Process: Building Heating and Cooling Load Calculation

4.5.1.1. Introduction

Overview:

Load calculations serve as the basis for all design stages of the building services design. The results of the load calculations enable the designer to dimension the plant equipment and to determine the required space for plant room.

Load calculations are an official proofing method (in Germany for example the proof for heat loss protection must be given in the course of a project), a mode for calculating the heating/cooling load or for the yearly dynamic load simulation:

The process terminates in the complete calculations and the data exchange into the IFC model.

The chapter on hand defines the prerequisites for the computer-aided load calculation .

Process Scope:

- *Calculating heating/cooling load*

Out-of-Scope:

- *bounding conditions like adjacent buildings,*

Definitions:

- *DIN*
- *ISO*
- *VDI*
- *ASHRAE*

References:

- *DIN 4701, 4108*
- *VDI 6021*
- *VDI 2078*

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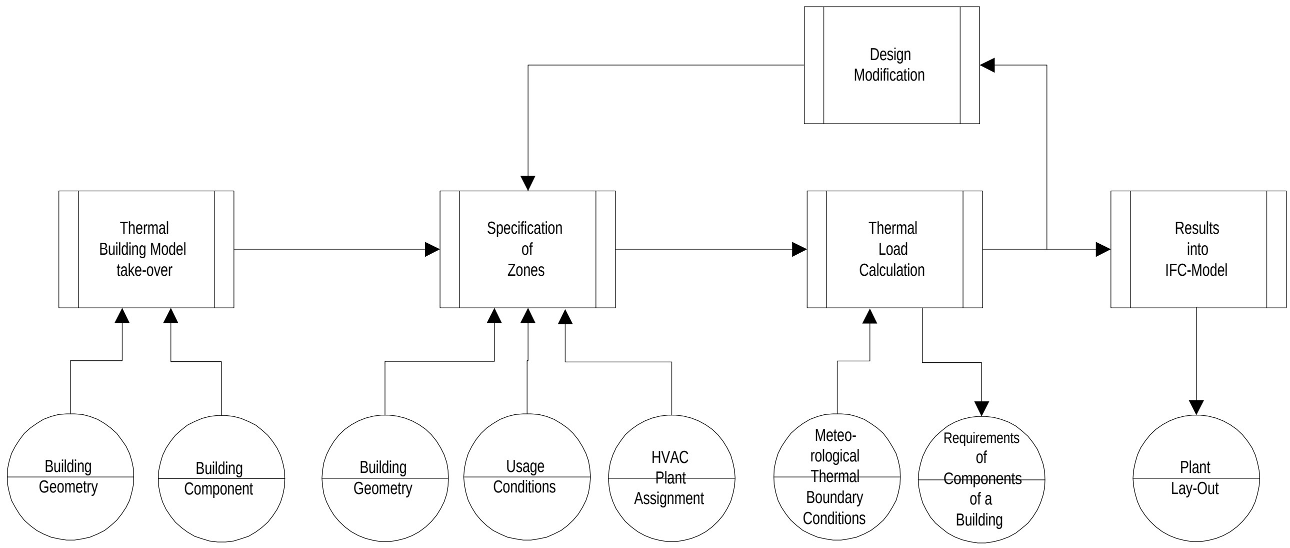
4.5.1.2. Process Diagram: Building Heating and Cooling Load Calculation



4.5.1.3. Process Definition: Building Heating and Cooling Load Calculation

4.5.1.3.1. Overview

After the completion of the building model with its geometric and physical building specifications by the architect, the data is to be extracted using the IFC-Model. The IFC-Model includes all architectural building components of a defined room, the attributes and the relationships of the components to each other. The IFC-Model does not include any the description of the adjacent buildings (e.g. input for external shading).

The parameters like the room temperatures, required air changes, people or machine loads or other necessary data is submitted if known to the design team. If certain data is not know to the design team plausible data is assumed to provide preliminary answers.

National boundary conditions has to be transmitted alternatively or in respectively conformist form.

The data exchange to the Calculation-Software does not require any exchange of graphical data. The exchange should be independent from the calculation method applied because it describes only the physical data.

After the exchange of data, the engineer checks data transmitted for completeness and possibly amend the data. The engineer has to input the boundary conditions as well as the meteorological data for the load calculation method.

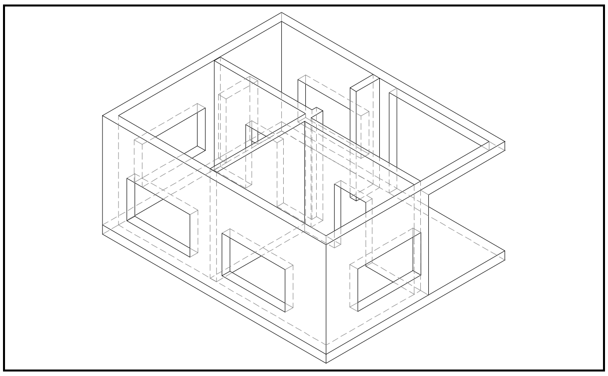
The definition of zones, as a result of the assigned plant equipment, can be carried out by simply numbering them. All rooms of one level having common boundaries can be defined as one zone. Another form of zoning can be made by direct plant assignment. This method ensures, that considerations of energy as well as the simultaneity of use conditions within plants are considered.

As a results of load calculations, the physical qualities of building components may be changed and submitted to an optimization process. This is requested to the IFC-building model. After changing the corresponding data a further exchange of basic data is carried out and the process starts once more.

A revision phase is necessary if there is change to the plant assignment or there are variations to the boundary conditions within the process.

At the end of the process the results of the load calculations are provided for the IFC model for further processing. The definition of technical stations, pathway and their space requirements as well as the dimensioning of system components for building services design are based on these results.

4.5.1.3.2. Task A - IFC-Model take-over



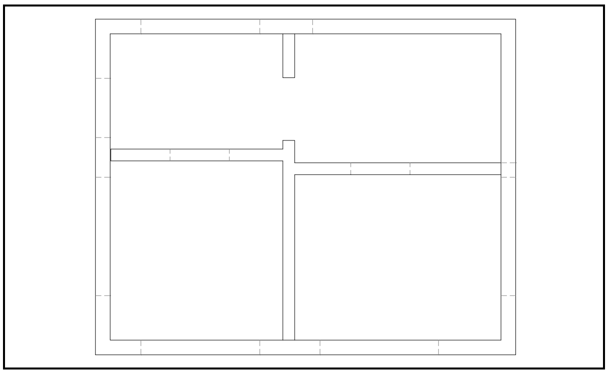
Task Description:

This step contains the import of extracted data from the building model like component geometry and component qualities. The construction of this physical data exchange format corresponds in the construction to a Physical-STEP file.

Example Usage Scenario:

None provided

4.5.1.3.3. Task B - Specification of zones



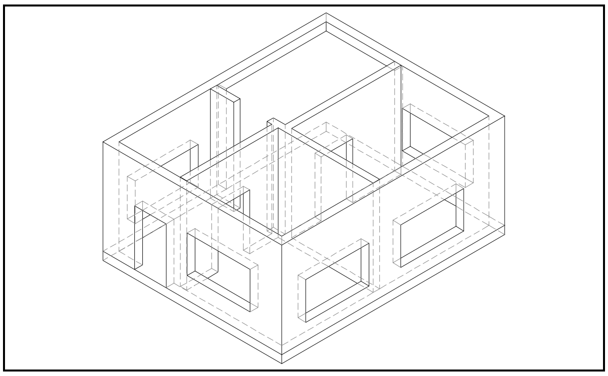
Task Description:

Considering the building geometry, zones are defined for the execution of the load calculations.

Example Usage Scenario:

None provided

4.5.1.3.4. Task C - Load calculations



Task Description:

This step contains the execution of the load calculations.

Example Usage Scenario:

None provided

4.5.1.3.5. Task D - Results into IFC-Model

Task Description:

Exchanging the results of the load calculations to the IFC model.

Example Usage Scenario:

None provided

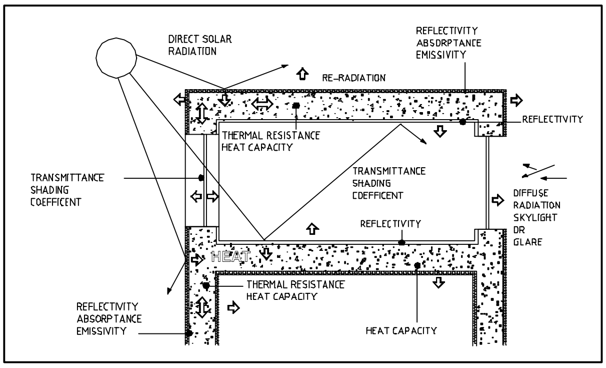
4.5.1.3.6. Task E - Design modifications

Task Description:

This step contains the iterative event for the execution of all calculations by variation or change of the zones, usage requirements etc., according to optimization by changing parameters .

Example Usage Scenario:

None provided



4.6. [CS-1] Code Checking - Energy Codes

Processes Defined in this project:

3. Commercial and Residential Energy Code Compliance Checking

Code compliance is performed by building designers, systems designers, and code enforcement officials. Compliance with codes begins during programming when designers determine which codes apply to the building project. Preliminary code reviews are frequently performed during schematic design and more thorough reviews are performed by members of the design team late in the design process before construction documents are complete. Building code officials perform plan reviews as part of the building permitting process. Designers and code officials perform drawing takeoffs as necessary to ensure compliance. Information about building systems, assemblies, layout, etc. is gathered during this process and compared to the requirements for each applicable code. Virtually all systems within a building are constrained in some way by codes (or voluntary design standards), hence codes are relevant to most other design processes. Energy codes, the subject of this Release 2.0 proposal, are strongly related to architectural, HVAC, and electrical design processes.

Code compliance checking is the process of assessing whether a building complies with codes enforced by local jurisdictions or with voluntary design standards promulgating by various standard-writing entities.

4.6.1. Process: Commercial and Residential Energy Code Compliance Checking

4.6.1.1. Introduction

Overview:

This process will support applications that determine whether buildings conform with energy-efficiency codes for new construction. The CS-1 project will focus on two model codes that are widely used in the United States. The project will primarily address requirements pertinent to building envelope and lighting.

Process Scope:

- Commercial energy code compliance (e.g., ASHRAE/IES 90.1-1989 [Code])
- Residential energy code compliance (e.g., MEC)
- Prescriptive code requirements
- Performance code requirements

Out-of-Scope:

- Determination of which codes apply
- Modeling of code requirements (i.e., the object model will not include the code requirements)
- Modeling of energy code provisions not normally addressed on the building plans; e.g. compliance procedures, detailed product and construction specifications, and other information normally relegated to project specifications.

Definitions:

- MEC: Model Energy Code
- HVAC: heating, ventilating, and air-conditioning

References:

- Model Energy Code, The Council of American Building Officials; Falls Church, VA; 1993.
- ASHRAE/IES Standard 90.1-1989, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings; ASHRAE, Atlanta, GA; 1989.
- Energy Code for Commercial and High-Rise Residential Buildings, Codification of ASHRAE/IES 90.1-1989 Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings; ASHRAE, Atlanta, GA; 1993.

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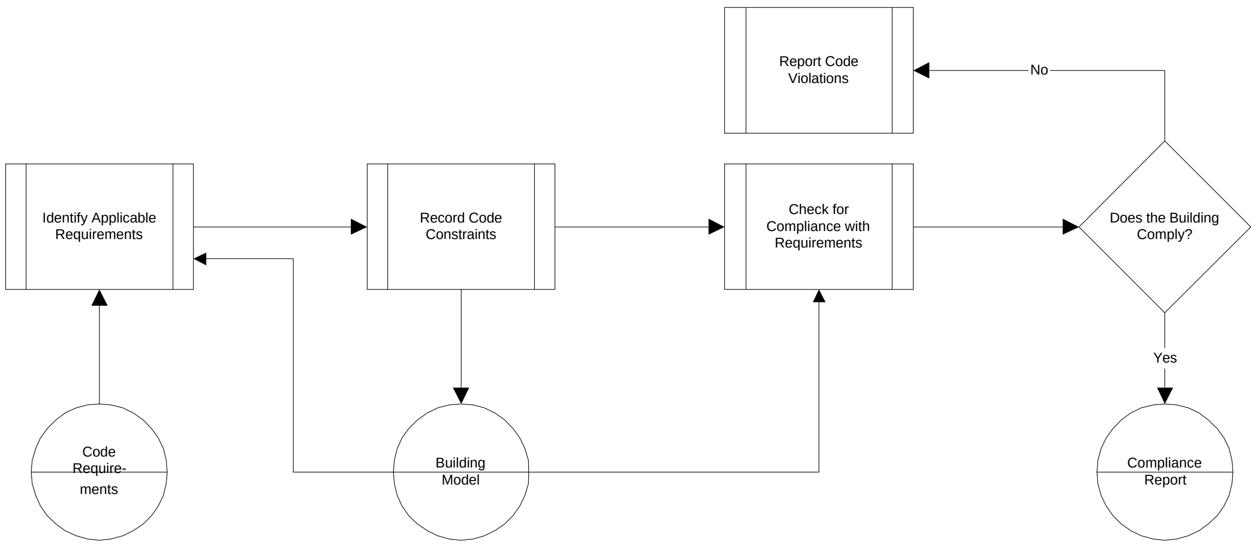
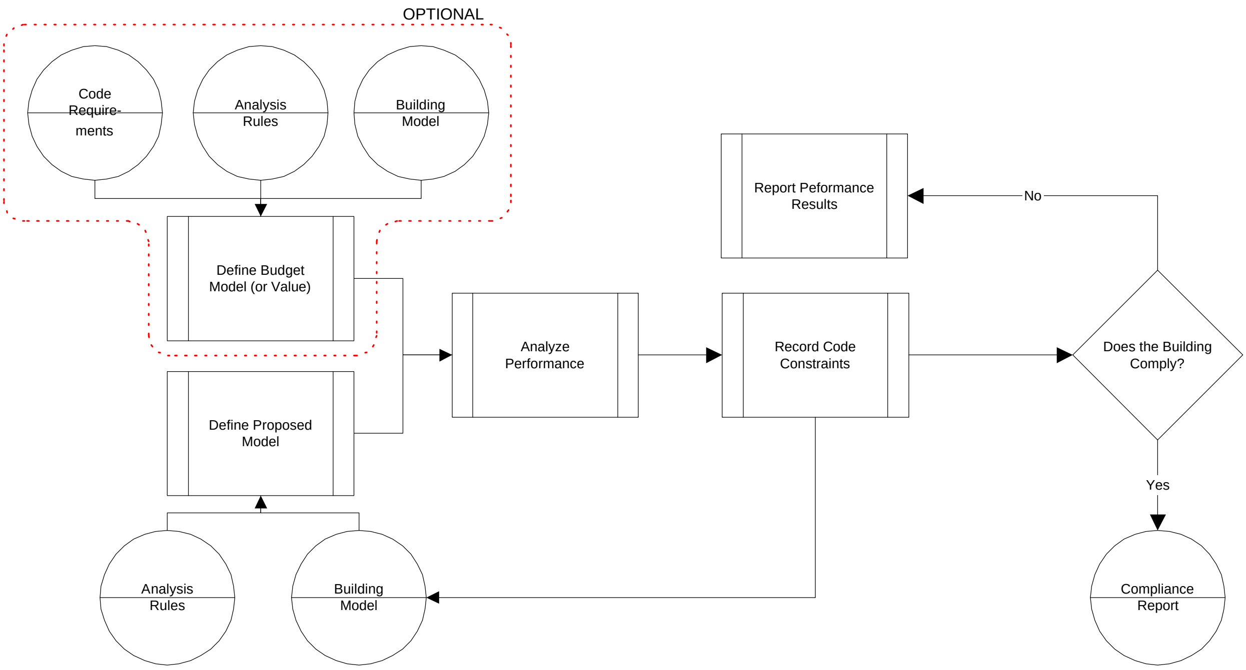
4.6.1.2. Process Diagram: Commercial and Residential Energy Code Compliance Checking

Note: Building codes typically employ two different regulatory approaches: prescriptive requirements and performance requirements. The two-part diagram below illustrates the two different processes corresponding with these two different approaches. Most codes are neither purely prescriptive nor purely performance-based, but rather, contain elements of both types of requirements either in combination or as alternative paths for demonstrating compliance. In its simplest form, a prescriptive requirement says that object or attribute A must have value B. In contrast a performance requirement says object A must perform as well as C, where C can range from a model whose performance must be analyzed to a static value for a performance metric.

Part A - Process for Prescriptive Code Requirements



Part B - Process for Performance Code Requirements



4.6.1.3. Process Definition: Commercial and Residential Energy Code Compliance Checking

4.6.1.3.1. Overview

Applicable energy codes are normally identified at the programming stage of the project. At the beginning of schematic design, the architect, HVAC engineer, energy consultant, or other designated design team member with responsibility for energy code compliance identifies those code requirements likely to constrain the building design. Depending on the severity of the code constraints, compliance with these requirements may be spot checked as the design process progresses, or the energy requirements may be largely ignored until a final compliance check is done, usually at the end of the design development phase of the project.

Most energy code requirements are not strictly prescriptive, but rather constrain the performance of an assembly, subsystem, or major building system. Determining compliance with these requirements frequently requires multiple inputs and some computation. Enabling the necessary data to be managed and manipulated using IFC's will eliminate manual tasks and enable energy code compliance to be checked more easily and frequently during the design process, resulting in compliance at lower cost and with less disruption to the design process. The capability to associate code constraints with objects in the building model will enable design applications to monitor conformance with codes without concurrent operation of code-checking applications. Designers can then focus on the design with confidence that they will be notified if proposed design changes violate code requirements.

4.6.1.3.2. Task A - Identify Applicable Code Requirements

Task Description:

This process begins with the intent to demonstrate that a given proposed building design complies with a given energy code.

Some requirements in the code (or even major sections of the code) may not apply due to particular characteristics of the project, such as its location, intended use, or number of stories. Some specific energy code-related examples of requirements that are conditionally applicable based on project characteristics are listed below.

- Certain buildings may be exempted from all envelope insulation requirements based on very low connected loads or the absence of space-conditioning equipment.
- Insulation of the exposed perimeter edges of slab-on-grade construction is required in climates with greater than 3,000 heating degree days base 65ºF but is not required in climates with 3,000 or fewer heating degree days.

The applicability of other code requirements may depend on specific conditions or exceptions in the code or on definitions of the objects addressed in the requirements. These conditions must be evaluated before the relationship between a building object and an applicable code constraint can be established. Some examples of these conditions are listed below.

- Exterior above-grade walls are subject to insulation requirements, but parapet walls and wing walls are exempt from these requirements.
- Insulation requirements apply to interior walls separating conditioned from unconditioned spaces but otherwise do not apply to interior walls.
- Basement wall insulation is required in many locations, but it is not required when walls are more than one story below grade.
- Either wall or roof insulation requirements may apply to steeply sloping roofs depending on the slope of the assembly.
- Lighting efficiency requirements apply for most building use types, but they do not apply to hotel guest rooms.

Example Usage Scenario:

Figure 1 shows an insulated slab edge. The applicability of code requirements governing the R-value and depth of this insulation is dependent on the climate in which the building is built and whether or not the slab edge occurs at the boundary between conditioned and unconditioned space. If the location has 3,000 or fewer heating degree days base 65°F or if the space circumscribed by the slab perimeter is unconditioned, no slab edge insulation is required.

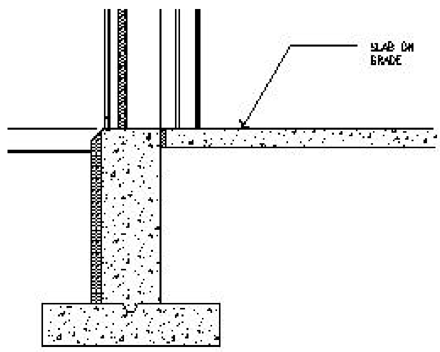


Figure 1 - Insulated Slab-on-Grade Perimeter

Figure 2 shows a parapet wall. Although on the building elevation the parapet wall may be indistinguishable from the exterior wall, the insulation requirement that applies to the exterior wall does not apply to the parapet wall.

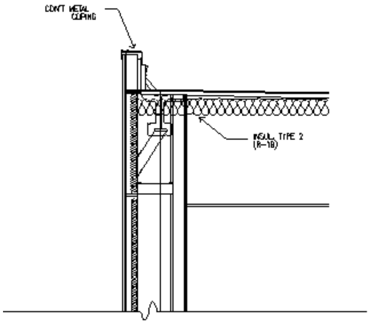


Figure 2 - Parapet Wall

4.6.1.3.3. Task B - Record Code Constraints

Task Description:

Where code requirements constrain the building design, it may be useful to record the code constraint for future use by other applications. The value of storing code constraint information in the building model (as opposed to simply reporting a compliance result) is that it can provide persistent guidance to the user and enable user notification when design modifications are made that will affect compliance. Prescriptive code constraints can be represented as discrete limiting values, which can be associated with a building object and stored in the building model for other applications to utilize and to document the basis for design decisions.

In order for this constraint object to be fully useful, it needs to carry the following information:

- The object to which the constraint is connected
- The numeric and logical content of the constraint
- Identification of the code to which the constraint belongs
- Identification of the application that established the constraint
- A description of the constraint
- Text to be used in notifying the user about the constraint
- Other objects and attributes on which the value or application of the constraint depends.

Unlike with prescriptive requirements, a performance-based requirement cannot be expressed as a discrete constraint on an individual object. Rather, the constraint is typically imposed on a system consisting of multiple objects that interact within the code-constrained system. To accommodate performance-based code constraints, it is necessary to attach the constraints to aggregate objects. In addition, many, though not all, performance codes employ requirements that are not fixed values but rather are themselves the results of calculations. These requirements tend to have a larger number of dependencies on other objects in the model, and hence are more likely to be affected by other design changes.

Example Usage Scenario:

Figure 3 shows a window assembly consisting of a window and a window frame. The U-factor of the window assembly--not the glass or the frame but the combined assembly--is constrained by a code requirement. For purposes of this example, the code constraint (from ASHRAE/IES Standard 90.1-1989) is that the U-factor of the window assembly may not exceed 0.72 Btu/(h·ft^2·°F). Listed below is the information that would be recorded with the code constraint and that would be available to other applications.

Code constraint attached to aggregate object *Window Assembly*.

- Numeric and Logical Content: Window assembly U-factor must be less than or equal to 0.72 Btu/(h·ft^2·°F).
- Identification of Code and Section Number: ASHRAE/IES Standard 90.1-1989, Section 8.6.10.2(b).
- Constraint Established By: COM*check-EZ*, Version 2.0.
- Description of Constraint: The code requires that locations with greater than 3,000 heating degree days base 65°F have an overall U-factor (i.e., including both glass and frame) that does not exceed 0.72 Btu/(h·ft^2·°F).
- Text for User Notification: "The overall U-factor (i.e., including both glass and frame) exceeds 0.72 Btu/(h·ft^2·°F) and therefore violates ASHRAE/IES Standard 90.1-1989, Section 8.6.10.2(b)."

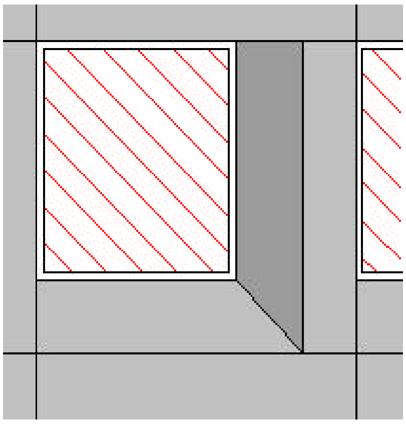


Figure 3 - Window and Frame

This Constraint Depends On: 1) site heating degree days base 65°F, 2) space conditioning of parent space, 3) glass U-factor, 4) glass area, 5) frame U-factor, and 6) frame

4.6.1.3.4. Task C - Check for Compliance with Prescriptive Requirements

Task Description:

This second step for compliance checking with prescriptive code requirements involves a logical comparison of the applicable prescriptive requirements in the code with the corresponding objects and attributes in the building model. This checking process yields both a status result and a code constraint on each of the corresponding building attributes. Commercial energy codes usually contain requirements that pertain to the architectural envelope, lighting systems, and HVAC and service water heating systems. Residential energy codes usually address only building envelope, HVAC, and water heating.

Example Usage Scenario:

Figure 1 shows the perimeter of a concrete slab on grade that has been insulated using vertically placed insulation that extends downward 24" from the top of the slab. In Minneapolis, this insulation must have an R-value of 8 or greater. The compliance checking process for prescriptive requirements simply involves executing logical comparisons between the applicable code requirements and the corresponding attribute(s) of code-constrained objects.

4.6.1.3.5. Task D - Define Budget Model

Task Description:

Compliance checking with performance-based requirements frequently requires that three steps be taken that are not required with prescriptive requirements: defining a budget building model, defining a proposed building model, and analyzing the performance of each. Defining the budget model (i.e., the model or building configuration that defines code-minimum performance) is typically performed by implementing prescriptive code requirements into a copy of the description of the proposed design. For example, the code checking procedure may substitute the prescriptive wall and roof insulation requirements for those used in the proposed design. Other assumptions may be imposed to ensure a fair basis for comparison with the performance results from the proposed model; for example, by specifying consistent operating assumptions and energy prices. In addition to implementing these modifications, this step involves translating the representation in the building model to the appropriate representation and format required by the simulation model used to analyze performance.

However, as indicated in the process diagram, a common variation for performance code requirements is to have the budget value be a static metric of performance. In this case, the process simplifies to a logical comparison of performance values similar to the prescriptive compliance check.

Example Usage Scenario:

Figure 4 shows a building floor plan with three different space usage (or task area) designations. The lighting sections of commercial building energy codes set lighting power budgets for various types of spaces based on their usage. The lighting power budget is generated by multiplying the area of each space type by its permitted lighting power density. This approach is performance-based because the resulting budget is applied at the whole-building level, and users are free to use any combination of lighting fixture types and quantities provided the aggregate input wattage does not exceed the budget.

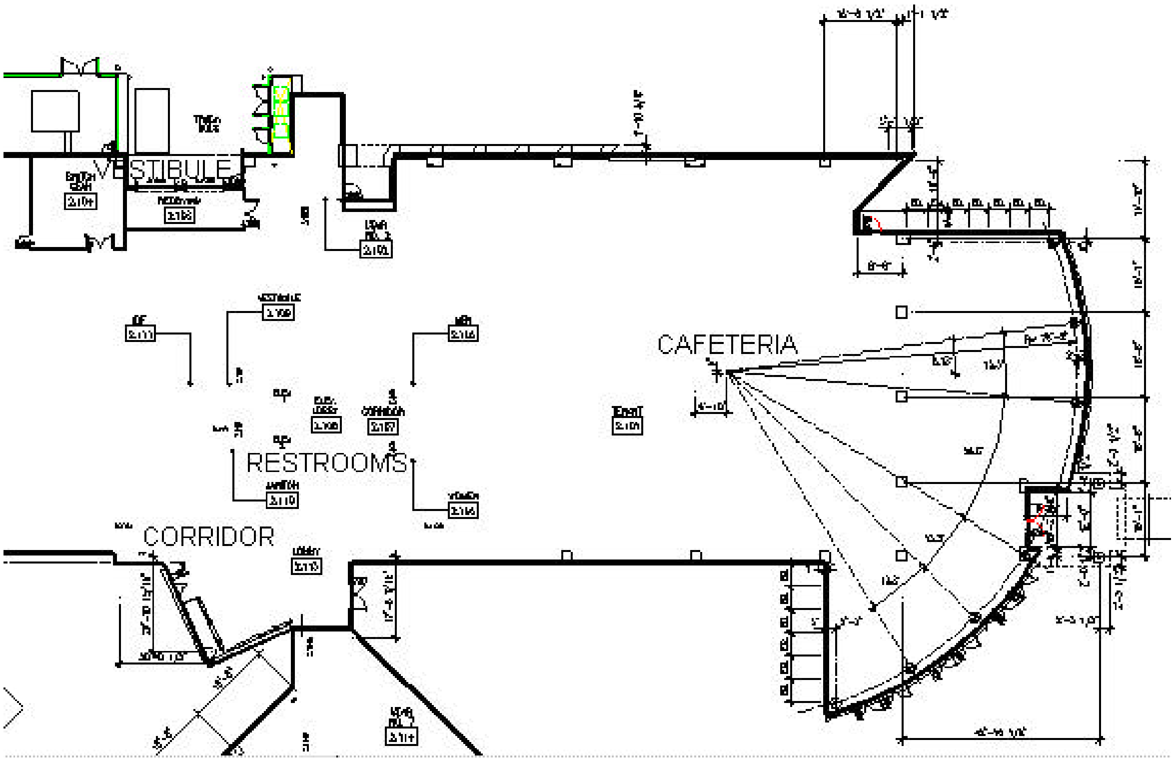


Figure 4 - Floor Plan

The actual values that make up the lighting budget model are shown in Table 1.

Table 1 - Example Budget Model for Performance-Based Lighting Compliance

Space Type Designation	Floor Area (ft^2)	Lighting Power Density (W/ft^2)	Lighting Power Budget (W)
Cafeteria	4,400	2.5	11,000
Restrooms	300	0.8	240
Vestibule	800	1.0	800
Corridor/Stairs	1,000	0.8	800
Total	6,500	---	12,840

4.6.1.3.6. Task E - Define Proposed Model

Task Description:

A similar process is used to define the proposed model as was used to define the budget model. Most objects in this model are defined directly from the building model entered by the user, however some assumptions may be imposed to ensure a fair comparisons between budget and proposed models. A similar translation is made to the required format for the simulation model.

Example Usage Scenario:

Figure 5 shows the reflected ceiling plan for the same areas shown in Figure 4. For lighting compliance, the fixture descriptions, quantities, and input wattages that are specified for the building are used to define the proposed model. Table 2 lists the parameter values for the system shown on the reflected ceiling plan (Figure 5).

[Add Reflected Ceiling Plan Here]

Figure 5 - Reflected Ceiling Plan

Table 2 - Proposed Design Model for Performance-Based Lighting Compliance

Fixture Description	**Quantity**	**Input Wattage (W)**	**Design Lighting Power**
Total			

4.6.1.3.7. Task F - Analyze Performance

Task Description:

The third step with performance code requirements is to calculate the performance of the two models, one representing the design proposed by the user and the other establishing code-minimum performance. While this process description implies that a the analysis involves a complex process, the basic sequence is applicable to a wide range of analysis procedures. The required calculation may be as simple as a parallel path calculation that combines the rated thermal conductances of two components to determine an overall assembly conductance (as in Figure 3 for the window assembly), or it may be as complex as an annual computer simulation of building energy use for a multi-zone building.

Example Usage Scenario:

Table 1 and Table 2 show the calculation of lighting power budget and the connected load for the proposed design. In this lighting compliance example, the performance analysis involves multiplying values in each of the rows and summing the products in the right-most columns.

4.6.1.3.8. Task G - Compliance Determination and Reporting

Task Description:

Depending on the compliance outcome from the code checking sequence, the user is either notified of the code violation or notified that the design complies and given the opportunity to generate a compliance report for submission as part of the building permit application. When a prescriptive code requirement is violated, the specific features that violate the requirement are listed for the user along with the corresponding code constraints. Such notification normally prompts the user to modify the design and rerun the compliance check to document compliance. The user may also leave the design unchanged and demonstrate compliance using an alternative, performance-based compliance method.

Unlike with prescriptive requirements, a failure to comply with a performance-based requirement cannot be attributed to the violation of a specific requirement but may depend on a large number of building objects. Results from a performance code evaluation are reported in the form of performance relative to a performance budget. This fact often leads the user to an iterative process to resolve the code violation. The user evaluates various ways of achieving compliance, and often a variety of design and cost issues are considered before a design change is accepted.

Example Usage Scenario:

Figure 6 shows a portion of a compliance report from an energy code application that has both prescriptive and performance-based requirements. Note that at the bottom of the page, the report indicates that the building complies by a certain percentage with the performance requirements of the code but that it also notes the violation of a specific prescriptive requirement. In this case, the example building will not comply until the violation of the prescriptive requirement is corrected.

ENVELOPE COMPLIANCE CERTIFICATE
COMcheck-EZ Software Version 2.0

Permit #
Chkd by/Date

Section 1: PROJECT INFORMATION

Project Information:
ABC Stores Inc.
1234 5th Ave.
George, Washington 98765

Designer/Contractor Information:
ENR Design and Construction Inc.
567 George Washington Way
Martha, Washington 98766

CLIMATE-SPECIFIC REQUIREMENTS

Component Name/Description	Area	Cavity R-Value	Cont. R-Value	Assembly U-Factor	Budget U-Factor
ROOF: Nonwood Joist/Truss	4500	0.0	16.0	0.060	0.057
WALL: Metal Frame, 16" o.c.	600	13.0	0.0	0.132	0.086
WALL: CMU >8"/Int. Ins/Mtl	1200	13.0	0.0	0.112	0.086
WALL: CMU >8"/Int. Ins	680	--	0.0	0.273	0.086
WIN: Low-E/Clr/Tbrk/SHGC=0.71/PF	500	--	--	0.570	--
WARNING: The following window violates a mandatory U-factor requirement					
WIN: Single/Clr/Mtl/SHGC=0.87/PF	100	--	--	1.170	--
DOOR: Opaque	35	--	--	0.700	--
DOOR: Glass	40	--	--	0.920	--
SLAB: Unheated w/36" Vertical	280	--	6.0	--	--

Envelope PASSES Performance Requirements: Design 2% better than code.

Figure 6 **- Example Energy Code Compliance Report**

4.7. [CS-2]

4.8. [ES-1]

4.9. [FM-3]

4.10. [FM-4]

4.11. [SI-1]

4.12. [XM-2]

5. Information Requirements Analysis

5.1. [AR-1] Architectural Model Extensions

5.1.1. Process: Building Shell Design

5.1.1.1. Information Analysis by Task

Please see the process overview description, process diagram and detailed process definition for this process in the "AEC+FM Industry Process Definitions" section of this document.

5.1.1.1.1. Task 1 - Preliminary Building Massing (option 1)

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *A bubble diagram laid out floor by floor (Architecture block & stack)*
- *Structural depths (Structural)*
- *Codes*
- *Core/Circulation*
- *Roof Design*
- *Floor to Ceiling heights*
- *Preliminary BS depths*

Output Information:

- *Refined floor plate shapes (Structural, Architecture)*
- *Refined floor to floor heights (Structural, Architecture)*
- *Volume and massing of the building (Architecture, HVAC, Simulation, Analysis)*
- *Preliminary elevation shape (Architecture)*
- *Exterior Circulation (ramps, balconies, docks, stairs, elevators)*

5.1.1.1.2. Task 2 - Determine Relationship between Shell and Structure

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *Preliminary Massing Studies*
- *Climate*
- *Context*
- *Architectural Styles*
- *Preliminary Design Grid (Architecture)*
- *Preliminary Structural Grid/System (Structural)*

Output Information:

- *Floor plates and design grid (Structural, Architecture)*
- *Refined elevation and model (Architecture)*

5.1.1.1.3. Task 3 - Determine Fenestration (aesthetic criteria)

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *Refined floor plate shapes (Structural, Architecture, Construction)*
- *Refined floor to floor heights (Structural, Architecture)*

- *Preliminary Structural Depths (Structural)*
- *Architectural Styles*
- *Manufactured Systems*
- *Volume and massing of the building (Architecture, HVAC, Simulation, Analysis)*
- *Code requirements (fire access, sill heights, energy)*
- *Preliminary elevation shape (Architecture, Structural)*
- *Building Orientation (Architecture)*

Output Information:
- *Window/Door dimensions (Architecture, HVAC, Simulation, Construction, Analysis)*
- *Window/Door locations (Architecture, HVAC, Simulation, Construction, Analysis)*
- *Glass Area (Architecture, HVAC, Simulation, Construction, Analysis)*
- *Window/Door Type (Architecture (HVAC, Simulation, Construction, Analysis)*
- *Window/Door Framing (Architecture, HVAC, Simulation, Construction, Analysis)*
- *Shading elements (overhang, brise desoleil, landscape elements, Analysis)*

5.1.1.1.4. Task 4 - Define Shell Materials

See task description and usage scenario in the Process Definitions section above.

Input Information:
- *Project Material List (Architecture, Client)*
- *Architectural Context*
- *Lifecycle concerns*
- *Construction Methods (Construction)*
- *Code Considerations*

Output Information:
- *Exterior wall type (HVAC, Simulation, Structural, Construction, Analysis)*
    - *Composition*
    - *Materials*
    - *Connections*
- *Window/Door Type*
    - *Composition*
    - *Materials*
- *Project documents (information to others)*

5.1.1.1.5. Task 5 - Costs

See task description and usage scenario in the Process Definitions section above.

Input Information:
- *Fenestration (Architecture)*
- *Wall type (Architecture)*
- *Window/Door type (Architecture)*
- *Exterior Circulation (ramps, balconies, docks, stairs, elevators)*
- *Preliminary Building Services*
- *Occupancy*
- *Loads (lighting, ventilation)*
- *Waste Stream (greening)*

Output Information:
- *Heat gain numbers*
- *Heat Loss numbers*
- *Preliminary energy analysis*
- *Material*
- *Equipment*
- *Life Cycle Costs/Trade-Offs*
- *Waste Stream/Trade-Offs (greening)*
- *Construction Time*

5.1.1.1.6. Task 6 - Visual Design Refinements

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *Wall Type (Architecture)*
- *Cost*
- *Scale*
- *Building Services*
- *Relationship of Materials*
- *Architectural Style (Architecture)*

Output Information:

- *Details on adornment (Structural, Construction)*

5.1.1.2. IFC Model Impact

This section summarizes the model requirements from all the process tasks analyzed above into two groups Extensions to R1.5.1 model object types and proposed new object types for R2.0.

Extensions to IFC R1.5 object types

- *IfcWindow*

  Data
  - *{{ Data description type }}*
    - *{{ notes }}*

- *IfcDoor*

  Data
  - *{{ Data description type }}*
    - *{{ notes }}*

New object types required in IFC R2.0

- *Parapet IfcWall::Type = parapet*

  Data
  - *{{ Data description type }}*
    - *{{ notes }}*

- *Snow Build UP*

  Data
  - *{{ Data description type }}*
    - *{{ notes }}*

- *Wind*

  Data
  - *{{ Data description type }}*
    - *{{ notes }}*

- *Height*

  Data
  - *{{ Data description type }}*
    - *{{ notes }}*

- *Function (Handrail/Safety, Screening)*

  Data
  - *{{ Data description type }}*
    - *{{ notes }}*

- *Louver*

  Data
  - Geometry type
  - Details type
  - Material type
  - Finish type
  - Free Area (ventilation) type
  - Screen/mesh size type
    - *Structural framing for hole (detailed enough???)*

- *Stair (See Stair Process)*

  Data
  - {{ Data description type }}
    - *{{ notes }}*

- *Ramp*

  Data
  - Geometry type
  - Material type
  - Finish type
  - Handrail (link) type
    - *see Handrail*
  - Guardrail (link) type
    - *see Guardrail*
  - Building code (link) type

- *Projections (ornamentation) NOTE: better word???*

  Data
  - Type (Canopy, Flag Pole, gargoyle, prefabricated balcony) type
  - Geometry type
  - Material type
  - Weight type
  - Manufacturer type
  - Orientation type
  - Connections to façade (e.g. bolt, steel clip, etc.) type

- *Curtain wall (window wall) (Look at CSI code Uniformat)*

  Data
  - Assembly type
  - Surface (link) type
  - Manufacturer type
  - Detail type
  - Building code (link) type
  - Specification (link) type

- *Foundation (elements, connections) see foundation design*

***** Note: need to know: floor to floor; floor plate; topography(grade)*****

5.1.1.3. RoadMap Issues

Interoperability Value

Disciplines/Applications from which information is needed:

- *Structural*
- *HVAC*
- *Energy*
- *Codes*

Disciplines/Applications to which information will be supplied:

- *HVAC*
- *Simulation*
- *Construction*
- *Facility Management*
- *Specifications*

Value of software supporting this process

In this section, other domain teams will rank the value of software which supports this process, based on IFC.

- *{{ discipline 1 }} - {{value from 1-10, 1 being the lowest value, 10 being the highest value}}*
- *{{ discipline 2 }} - {{value from 1-10}}*

Sponsor Software Companies

The following software companies have shown interest in developing applications which implement the process

- *{{ company 1 }}*
- *{{ company 2 }}*

5.1.1.4. Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues

Proposed resolution

- {{ Issue 1 }}
  - {{ Proposed resolution }}
- {{ Issue 2 }}
  - {{ Proposed resolution }}

5.1.2. Process: Building Core Design

See Process Definitions section above.

5.1.2.1. Information Analysis by Task

Please see the process overview description, process diagram and detailed process definition for this process in the "AEC+FM Industry Process Definitions" section of this document.

5.1.2.1.1. Task 1 - Determine Core Spaces Needed

See task description and usage scenario in the Process Definitions section above.

Input Information:

· *Space program (owner requirements)*

- *Occupancy (Floor by Floor)*
- *Occupancy Type (Assembly, etc in code)*
- *Codes/Egress (Distances) (Look to AR-2)*
- *Building Services (# and type of service)*
- *Vertical Circulation (#, type)*

Output Information:
- *Spaces (#,type)*

5.1.2.1.2. Task 2 - Determine Core Space Sizes

See task description and usage scenario in the Process Definitions section above.

Input Information:
- *Calculate elevators (Number and sizes length, width, and type (freight vs. passenger)(Freight lobbies)*
- *Calculate Stairs (process #### Length, width)*
- *Floor to Floor Heights*
- *Number of Floors*
- *Calculate Escalator (width, length)*
- *Alarm Stations (width, length)*
- *Restroom Design (process #### length, width, area)*
- *Required spaces (length/width or area) Electrical, Communications, Waste Disposal, Janitorial, Mechanical*

Output Information:
- *Required spaces (length/width or area) (Collection of spaces ie (Core, parking)*

5.1.2.1.3. Task 3 - Layout Core Spaces

See task description and usage scenario in the Process Definitions section above.

Input Information:
- *Structural Grid (grid of object, including shear walls etc.*
- *Max. Distance between exit stairs.*
- *Space efficiency (% usable goal)*
- *Parking Plan*
- *Required spaces (length/width or area) Electrical, Communications, Waste Disposal, Janitorial, Mechanical, Stair, Elevator, Escalator*

Output Information:
- *Core layout (collection of spaces)*

5.1.2.1.4. Task 4 - Detailed Design of Stairs

Covered elsewhere - in Restroom design Process

5.1.2.1.5. Task 5 - Detailed Design of Restrooms

Covered elsewhere - in Restroom design Process

5.1.2.2. IFC Model Impact

This section summarizes the model requirements from all the process tasks analyzed above into two groups Extensions to R1.5.1 model object types and proposed new object types for R2.0.

Extensions to IFC R1.5 object types

- *None specified*

New object types required in IFC R2.0

- *Stairs (Actual object)*
  Data
  - *{{ Data description type }}*
    - *{{ notes }}*
- *Stairs Well*
  Data
  - *{{ Data description type }}*
    - *{{ notes }}*
- *Elevator Shaft*
  Data
  - *{{ Data description type }}*
    - *{{ notes }}*
- *Elevator*
  Data
  - *{{ Data description type }}*
    - *{{ notes }}*
- *Emergency services*
  Data
  - Fire Standpipe type
  - Hose type

5.1.2.3. RoadMap Issues

Interoperability Value

Disciplines/Applications from which information is needed:

- *Structural*
- *HVAC*
- *Telecommunications*
- *Plumbing*
- *Electrical*

Disciplines/Applications to which information will be supplied:

- *Structural*
- *HVAC*
- *Telecommunications*
- *Plumbing*
- *Electrical*
- *Specifications*

Value of software supporting this process

In this section, other domain teams will rank the value of software which supports this process, based on IFC.

- *{{ discipline 1 }} - {{value from 1-10, 1 being the lowest value, 10 being the highest value}}*
- *{{ discipline 2 }} - {{value from 1-10}}*

Sponsor Software Companies

The following software companies have shown interest in developing applications which implement the process }}

- *{{ company 1 }}*
- *{{ company 2 }}*

5.1.2.4. Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues

Proposed resolution

- {{ Issue 1 }}
    - {{ Proposed resolution }}
- {{ Issue 2 }}
    - {{ Proposed resolution }}

5.1.3. Process: Stair Design

See Process Definitions section above.

5.1.3.1. Information Analysis by Task

Please see the process overview description, process diagram and detailed process definition for this process in the "AEC+FM Industry Process Definitions" section of this document.

5.1.3.1.1. Task 1 - Locate Stairs

See task description and usage scenario in the Process Definitions section above.

Input Information:
- *Configuration (type straight, Scissors)*
- *Owner Requirements*
- *Codes*
- *Occupancy*
- *Circulation*
- *Core Inputs (location exit, etc.)*

Output Information:
- *Location and Type*

5.1.3.1.2. Task 2 - Determine Width

See task description and usage scenario in the Process Definitions section above.

Input Information:
- *Configuration (type straight, Scissors, spiral)*
- *Handrail projection (Depth)*
- *Clear Area (distance) between handrail*
- *Stair use (Fire stair, Ornamental)*
- *Codes (Tread Width(distance))*
- *Egress (# of occupants by building type)*
- *Owner Requirements (Grander defined width)*

Output Information:

- *Width of treads*

5.1.3.1.3. Task 3 - Determine Tread depth and Risers height

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *Floor to Floor Heights*
- *Acoustic rating (stc, impact rating)*
- *Codes (Max and min, ratio, nosing depth)*
- *Owner requirements (Depth, Rise) consistent fall within the ratio*

Output Information:

- *Tread depth*
- *Riser height*
- *Nosing Depth*
- *Landing Locations*
- *Material Type*
- *Finish*

5.1.3.1.4. Task 4 - Determine Landing

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *Stair Width*
- *Acoustic rating (stc, impact rating)*
- *Door, standpipe, handrail, clearance*
- *Special Criteria (depth, width)*

Output Information:

- *geometry of Landings*
- *Material Type*
- *Finish*

5.1.3.1.5. Task 5 - Guardrail Design

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *Code (min. /max height, balustrade spacing, Minimum penetration size)*
- *Special Criteria (min. /max height, balustrade spacing, Minimum penetration size)*

Output Information:

- *Guardrail geometry*
- *Material Type*
- *Finish*
- *Guardrail specifications (min. /max height, balustrade spacing, Minimum penetration size))*

5.1.3.1.6. Task 6 - Handrail Design

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *Code (Minimum projections, min. /max height, diameter, extension from base, extension from top, continuation)*
- *Stair configuration (egress, ornamental)*
- *Special Criteria (Minimum projections, min. /max height, diameter, extension from base, extension from top, continuation)*

Output Information:

- *Handrail geometry*
- *Material Type*
- *Finish*
- *Handrail specifications (Minimum projections, min. /max height, diameter, extension from base, extension from top, continuation)*

5.1.3.1.7. Task 7 - Construction and Materials

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *none identified*

Output Information:

- *none identified*

5.1.3.1.8. Task 8 - Finalize Design

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *Life Safety Requirements*
- *Exits*

Output Information:

- *Lighting needs*
- *Ventilation needs*
- *Pressurization*
- *Signage*
- *Stair Design*

5.1.3.2. IFC Model Impact

This section summarizes the model requirements from all the process tasks analyzed above into two groups Extensions to R1.5.1 model object types and proposed new object types for R2.0.

Extensions to IFC R1.5 object types

- *None specified*

New object types required in IFC R2.0

- *Treads*

  Data
  - *RiserHeight type*
  - *TreadDepth type*
  - *TreadMaterial*
  - *NosingMaterial*
  - *TreadType*

- *Handrails*

  Data
  - *HandrailType type*
  - *Material type*
  - *DepthFromWall type*

- *Guardrails*

  Data

- *GuardrailType type*
- *Material type*
- *DepthFromWall*

- *Landings*

  Data

  - *Depth type*
  - *Width type*
  - *Material type*

- *Stringer*

  Data

  - *Depth type*
  - *Width type*
  - *Material type*
  - *Shape (surfaces) type*

5.1.3.3. RoadMap Issues

Interoperability Value

Disciplines/Applications from which information is needed:

- *Structural*
- *Codes*

Disciplines/Applications to which information will be supplied:

- *Plumbing*
- *Electrical*
- *Codes*
- *Construction*
- *Facility Management*
- *Structural*
- *Specifications*

Value of software supporting this process

In this section, other domain teams will rank the value of software which supports this process, based on IFC.

- *{{ discipline 1 }} - {{value from 1-10, 1 being the lowest value, 10 being the highest value}}*
- *{{ discipline 2 }} - {{value from 1-10}}*

Sponsor Software Companies

The following software companies have shown interest in developing applications which implement the process }}

- *{{ company 1 }}*
- *{{ company 2 }}*

5.1.3.4. Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues

Proposed resolution

- {{ Issue 1 }}
  - {{ Proposed resolution }}
- {{ Issue 2 }}
  - {{ Proposed resolution }}

5.1.4. Process: Public Restroom Design

See Process Definitions section above.

5.1.4.1. Information Analysis by Task

Please see the process overview description, process diagram and detailed process definition for this process in the "AEC+FM Industry Process Definitions" section of this document.

5.1.4.1.1. Task 1 - Determine Requirements

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *Occupancy type*
- *Program Occupancy (number)*
- *Floor area*
- *Municipal fixtures requirements*
- *ADA (clearances)*
- *Special Criteria (list of fixtures)*

Output Information:

- *Fixtures number and types and spacing(clearance) (urinal, WC wall, WC floor etc.)*

5.1.4.1.2. Task 2 - Layout

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *Fixtures (mounting height, clearances)*
- *Plumbing considerations (Renovation)*
- *Codes (Entry, turnaround space)*
- *accessories (grab bars, mirrors, paper towel, trash, partition etc.) mounting, clearances, width, length, height, depth.*
- *Core constraints (width, length, area, polygonal area)*
- *drainage*
- *Structural Grid*

Output Information:

- *Location, height of fixtures and accessories*
- *Location of walls, doors*
- *Space geometry*
- *FloorDrain*
- *Millwork (cabinets and counter tops)*

5.1.4.1.3. Task 3 - Construction Detailing, Finishes and Lighting

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *Space geometry*
- *Fixtures types, locations*
- *accessories (grab bars, mirrors, paper towel, trash, partition etc.) mounting, clearances, width, length, height, depth.*
- *Client requirements (ie. stone*

Output Information:

- *Partition types*
- *Fixture and accessories manufactures model etc.*
- *** Note: finish decisions ***

5.1.4.2. IFC Model Impact

This section summarizes the model requirements from all the process tasks analyzed above into two groups Extensions to R1.5.1 model object types and proposed new object types for R2.0.

Extensions to IFC R1.5 object types

- *None specified*

New object types required in IFC R2.0

- *Fixture (Anything coordinated with another discipline)*

  Data
  - *MoutingHeight type*
  - *DrainConnectionPoint type*
  - *HwConnectionPoint type*
  - *CwConnectionPoint type*
  - *ElectricalConnectionPoint type*
  - *RoughOpening type*
  - *Detail (link) type*
  - *BuildingCode (link) type*
  - *OperatingControlLocation (dispenser conforms to range) type*
  - *Material type*
  - *Finish type*
  - *AssociatedFitting type*
  - *GraphicSymbol type*
  - *Color type*
  - *MountingType type*
  - *Manufacturer type*

- *Accessories (Everything else)*

  Data
  - *MountinHeight type*
  - *BoundingBox type*
  - *RoughOpening type*
  - *Detail (link) type*
  - *BuildingCode (link) type*
  - *OperatingControlLocation (dispenser conforms to range) type*
  - *Material type*
  - *Finish type*
  - *Graphic Symbol type*

- *Color type*
- *MountingType type*
- *Manufacturer type*

- *Manufactured Partitions*

  Data
  - *Height type*
  - *Width type*
  - *Thickness type*
  - *Door (link) type*
  - *Hardware (link) type*
  - *Material type*
  - *Detail (link) type*
  - *Specification (link) type*
  - *Finish type*
  - *Mounting type*
  - *Manufacturer type*

- *Millwork (Casework)*

  Data
  - *MountingHeight type*
  - *Geometry type*
  - *MountingHardware type*
  - *Detail (link type)*
  - *Manufacturer type*

5.1.4.3. RoadMap Issues

Interoperability Value

Disciplines/Applications from which information is needed:

- *Structural*
- *Plumbing*
- *HVAC*
- *Electrical*

Disciplines/Applications to which information will be supplied:

- *HVAC*
- *Plumbing*
- *Structural*
- *Electrical*
- *Construction*
- *Facility Management*
- *Specifications*

Value of software supporting this process

In this section, other domain teams will rank the value of software which supports this process, based on IFC.

- *{{ discipline 1 }} - {{value from 1-10, 1 being the lowest value, 10 being the highest value}}*
- *{{ discipline 2 }} - {{value from 1-10}}*

Sponsor Software Companies

The following software companies have shown interest in developing applications which implement the process }}

- *{{ company 1 }}*
- *{{ company 2 }}*

5.1.4.4. Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues

Proposed resolution

- {{ Issue 1 }}
  - {{ Proposed resolution }}
- {{ Issue 2 }}
  - {{ Proposed resolution }}

5.1.5. Process: Roof Design

See Process Definitions section above.

5.1.5.1. Information Analysis by Task

Please see the process overview description, process diagram and detailed process definition for this process in the "AEC+FM Industry Process Definitions" section of this document.

5.1.5.1.1. Task 1 - Design Roof

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *Budget constraints*
- *Community and regional standards*
- *Environment such as snow or tepid regions*
- *Screening building services*
- *Image (height, patterns, fabric)*
- *Client Requirements (material which would effect pitch)*
- *Lifecycle Requirements*
- *Fire Exiting (penthouse)*
- *Alternative Energy (passive design, orientations, equipment)*
- *Live load based on use*
- *Codes (fire, class, slopes)*
- *Functional requirement (structural loading, pool,)*
- *Building massing*
- *Building materials*
- *Structural*
- *Surrounding Building Scapes*

Output Information:

- *Basic form of roof (i.e. Flat, pitched, shed, etc.)*
- *Material requirements (i.e. clay tile roofing, slate)*
- *Slope*
- *Structural depths*
- *Area of roof planes*
- *Vert/horz projections*

- *Lifecycle*

5.1.5.1.2. Task 2 - Skylight/Clear Story

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *Codes*
- *Environmental*
- *Structural*
- *Client requirements*
- *Day lighting*
- *Ventilation*
- *Lifecycle*
- *Design Intent*
- *Energy requirements*
- *Manufacturer input*

Output Information:

- *Geometry*
- *Glazing properties*
- *Materials (performance properties)*
- *Manufacture information*

5.1.5.1.3. Task 3 - Layout of Services

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *HVAC equipment and piping locations*
- *Telecommunications needs in respect to roof dishes etc.*
- *Plumbing venting stacks*
- *Circulation (stairwell)*
- *Roof Circulation*
- *Amenities (pool, heliport)*
- *Fire Protection*
- *Maintenance requirements*

Output Information:

- *Location and geometry of penetration*
- *Location geometry of loading*
- *Location of amenities and equipment*
- *Equipment access*

5.1.5.1.4. Task 4 - Design Rain/Snow Drainage

See task description and usage scenario in the Process Definitions section above.

Input Information:

- *Structure*
- *Roof geometry*
- *Contributing sources (adjacent surfaces walls etc.)*
- *Geographic location and weather information.*
- *Lifecycle (materials copper vs steel)*
- *Code requirements*
- *Site considerations (drainage)*

Output Information:

- *Water/Snow drainage plan*
- *Rough drain/downspouts location and sizes (interior drainage)*

· *Maintenance requirements*

5.1.5.2. IFC Model Impact

This section summarizes the model requirements from all the process tasks analyzed above into two groups Extensions to R1.5.1 model object types and proposed new object types for R2.0.

Extensions to IFC R1.5 object types

- *None specified*

New object types required in IFC R2.0

- *Stairs Well*
  Data
  - *{{ Data description type }}*
    - *{{ notes }}*
- *Roof*
  Data
  - *Style (flat, sloped, etc.) type*
  - *Fire Classification (A,B, …) type*
  - *Space (link) type*
    - *size and volume for ventilation*
- *Climate (Check spec and BS)*
  Data
  - *{{ Data description type }}*
    - *{{ notes }}*
- *RoofSurface*
  Data
  - *Geometry type*
  - *Assembly (material - membrane assembly type*
  - *Lifecycle (link)) type*
  - *Surface (link)) type*
  - *Specification (link)) type*
  - *FireClassification) type*
- *Surface ((?Material (property set) (have BS look at this object type) (Apply to all object)*
  Data
  - *Reflectivity type*
  - *RenderingAttribute (link to material) type*
  - *Color type*
  - *Roughness (list) friction coefficient) type*
  - *Transparency) type*
- *Specification (property set) (Apply to all object)*
  Data
  - *Section (pointer to file or contained text block) type*
- *Assembly (property set) (Apply to all object)*
  Data
  - *Factors (list for assembly) type*
  - *Material (link) (factors/attributes) type*
- *Lifecycle (property set) (Apply to all object)*
  Data

- *ServiceLife type*
- *Maintenance interval type*
- *Warranty type*
- *Salvage Value type*
- *Recyclability (property sets?) type*
- *Disposal (test field) type*
- *Cost (link) type*

- *Skylights (could be domed, barrel vault)*

  Data
  - *Geometry type*
  - *Location type*
  - *Manufacture type*
  - *Glazing type type*
    - *(Ufactor, solor head gain coefficient, vis light transmittance, layers, air space, shading coefficient) (Have someone look at galzing type code/BS)*
  - *GlazingArea) type*
  - *FrameType) type*
  - *Operable (same windows?)) type*
  - *VentilationArea) type*
  - *RoughOpening) type*
  - *FinishedOpening) type*
  - *EdgeType (assembly/detail)) type*
  - *LifeCycle) type*
    - *pulled out to Property set applied to all objects*

- *Joint (Expansion, Edge condition, Control Joint) (Have BS group review)*

  Data
  - *Assembly (fill the gap) type*
  - *Type (Expansion, Edge, Control, Score, Reveal) type*
  - *Pointer to objects type*
  - *Details type*
  - *FireRating type*
  - *Waterproof type*
  - *Ventilation type*
  - *Manufacturer type*
  - *RangeOfMovement type*
  - *DirectionOfMovement type*
  - *Lifecycle type*

- *Scupper (General opening/edge and object inserted to take)*

  Data
  - *Geometry type*
  - *Material type*
  - *Detail type*
  - *Manufacturer type*

- *RoofDrain/DownSpout (Have Plumbing look at it)*

  Data
  - *Detail type*
  - *Location type*
  - *Manufacturer type (text string?)*
  - *Specification (link) type*
  - *Material type*

- *Gutters (Have Plumbing look at it)*

Data
- *Geometry type*
- *Slope type*
- *Capacity type*
- *Detail type*
- *Interface - Drainage*
- *FlowVolume type*
- *TributaryArea (Roof planes, Adjacent Surfaces) type*
- *PrimaryDrainage type*
- *Secondard type*
- *Size type*
- *Interface - Snow*
- *SnowZone type*
- *Load type*

- *Mech screen (Separate object type?)*

  Data
  - *Length type*
  - *Width type*
  - *Height type*
  - *Type (assembly) type*

- *Window cleaning*
  (rigging, tracks, rails, carriage, apparatus, maybe this should be pulled out as a process)
  (Separate object type?)

  Data
  - *Location type*
  - *Type type*
  - *Connection type*

- *Projections (mechanical screens)*

  Data
  - *ProjectionType type*
  - *Length type*
  - *Material type*
  - *Weight type*
  - *Orientation type*
    - *vertical, horizontal, etc*
  - *Connection type*
    - *connection to facade ie. bolt, steel*

- *Stairs (See Stair Process)*

- *Access (walkways, etc)*

  Data
  - *Path type*
  - *Composition (assembly) type*
  - *Width type*

**** *Note:* Ask Energy guy about what is needed (parapet, etc) ****

5.1.5.3. RoadMap Issues

Interoperability Value

Disciplines/Applications from which information is needed:

- *Structural*
- *HVAC*
- *Plumbing*
- *Telecommunications*
- *Electrical*
- *Municipal codes*

Disciplines/Applications to which information will be supplied:

- *Structural*
- *Plumbing*
- *Telecommunications*
- *HVAC (heat gain/heat loss analysis)*
- *Electrical*
- *Municipal Codes*
- *Specifications*

Value of software supporting this process

In this section, other domain teams will rank the value of software which supports this process, based on IFC.

- *{{ discipline 1 }} - {{value from 1-10, 1 being the lowest value, 10 being the highest value}}*
- *{{ discipline 2 }} - {{value from 1-10}}*

Sponsor Software Companies

The following software companies have shown interest in developing applications which implement the process }}

- *{{ company 1 }}*
- *{{ company 2 }}*

5.1.5.4. Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues

Proposed resolution

- {{ Issue 1 }}
  - {{ Proposed resolution }}
- {{ Issue 2 }}
  - {{ Proposed resolution }}

5.2. [AR-2] Compartmentation of Buildings

5.2.1. Process: Compartmentation of buildings

5.2.1.1. Information Analysis by Task

Please see the process overview description, process diagram and detailed process definition for this process in the "AEC+FM Industry Process Definitions" section of this document.

5.2.1.1.1. Task A - Identify Main/Ancillary Use Spaces

See description in the Process definition section above.

Input Information:
- *Project Information*
- *Project Geometry*
- *Building Use Type*
- *Building Geometry*
- *Use Classification*
- *Occupancy*

Output Information:
- *Main Use Spaces*
- *Ancillary Use Spaces*

5.2.1.1.2. Task B - Adjust Main/Ancillary according to Code

See description in the Process definition section above.

Input Information:
- *Project Information*
- *Project Geometry*
- *Building Use Type*
- *Building Geometry*

Output Information:
- *Additional Main Use Spaces if any.*

5.2.1.1.3. Task C - Identify Single Occupancy Spaces

See description in the Process definition section above.

Input Information:
- *Project Information*
- *Project Geometry*
- *Building Use Type*
- *Building Geometry*
- *Use Classification*
- *Occupancy*

Output Information:
- *Single Occupancy Spaces*

5.2.1.1.4. Task D - Check Areas/Volumes to Design Fire Compartments

See description in the Process definition section above.

Input Information:
- *Main Use Spaces*

· *Single Occupancy Spaces.*

Output Information:

· *Fire Compartments.*

5.2.1.2. IFC Model Impact

This section summarizes the model requirements from all the process tasks analyzed above into two groups Extensions to R1.5.1 model object types and proposed new object types for R2.0.

Extensions to existing R1.5.1 Object Types

- *IfcProject*
- *IfcSite*
- *IfcBuilding*
- *IfcSpace*

New object types required in IFC R2.0

- *IfcMainUseSpace*
  Data
  - *FireUseClassification IfcClassification*
    - *(A MainUseSpace will have one Fire Use which is assigned from the FireUseClassification)*
- *IfcAncillaryUseSpace*
  Data
  - *FireUseClassification IfcClassification*
    - *(An AncillaryUseSpace will have one Fire Use which is assigned from the FireUseClassification. An AncillaryUseSpace is contained by one MainUseSpace)*
- *IfcSingleOccupancySpace*
  Data
  - *SingleOccupancyPossessor STRING*
    - *(Defines who possesses and uses a space for fire compartmentation purposes)*
- *IfcFireCompartment*
  Data
  - *UseType STRING*
    - *(no description)*

5.2.1.3. RoadMap Issues

Interoperability Value

Disciplines/Applications from which information is needed:

- *Client Brief*
- *Architecture Building Model)*
- *Services Engineers)*

Disciplines/Applications to which information will be supplied:

- *Architecture*

Target Software Companies/Application Type

- *Architects and Fire Officers*

- *CAD systems providers (Autodesk)/Autocad*
- *CAD-support FM applications /space planning, occupancy planning, and asset management databases*

Value of software supporting this process

In this section, other domain teams will rank the value of software which supports this process, based on IFC.

- *Architecture: High (in the top 5)*
- *FM: Very High (in the top 3)*
- *CM/Cost: Very High (in the top 3)*
- *Building Service:*
- *HVAC:*

Sponsor Software Companies

The following software companies have shown interest in developing applications which implement the process

- *Autodesk - UK*
- SSi

5.2.1.4. Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues

Proposed resolution

- {{ Issue 1 }}
  - {{ Proposed resolution }}
- {{ Issue 2 }}
  - {{ Proposed resolution }}

5.3. [BS-1] HVAC System Design

5.3.1. Process: HVAC Duct System Design

HVAC Duct System Design supports the design and representation of air distribution ductwork systems. Engineers typically perform these processes during the design phase of a building or project, prior to construction. The process culminates with a set of drawings, schedules, and specifications (construction documents) that can be bid upon and constructed.

5.3.1.1.1. Select and Locate System Components

This step involves selecting and locating the air terminals, boxes (if included in the design), and fans that compose the HVAC duct system.

Input Information:

- *Floor plans*
- *Ceiling grid plans*
- *Reflected ceiling plans*
- *Lighting plans*

- *Structural plans*
- *Sprinkler plans*
- *Piping plans*
- *Smoke detector plans*
- *Speaker plans*

Output Information:

- *Pset_AirTerminal*
- *Pset_CoordinationRequirement*
- *Pset_TerminalBox*
- *IfcPathwayElement*
- *IfcEquipment*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *IfcWall*
  Data
  - *All available data*
    - *Location and type information (i.e., fire ratings, special construction types, etc.). This allows the designer to identify the potential locations for air terminals, boxes and fans*

- *IfcSpace*
  Data
  - *Programme information*
    - *Information specific to the intended function of the space, which is used to determine the number and type of air terminals to be installed.*

- *IfcCeiling*
  Data
  - *Ceiling Type information*
    - *Information needed to determine the type and location of air terminals to be installed.*
    - *Information needed to determine clearances in interstitial spaces.*

- *IfcBeam*
  Data
  - *Type, size and location of beams*
    - *This information is needed to prevent conflicts with air terminals and terminal boxes.*

- *IfcFluidMover*
  Data
  - *All available data.*
    - *This information coupled with the Pset_Fan or Pset_AirHandlingUnit property sets are used to locate and initially specify the fan.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.1.1.2. Connect Components with Ducts and Fittings

This step involves using engineering judgment to connect the air terminals, boxes, and fans with ducts and fittings. This information is then used for preparing drawings or specifications which will schematically represent the system under design. These schematics are then used to begin coordination with other disciplines which are impacted by the system.

Input Information:

- *Floor plans*
- *Structural plans*

· *Pset_CoordinationRequirement*

Output Information:

· *Pset_DuctFitting*
· *Pset_DuctSegment*
· *IfcPathwayElement*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *IfcWall*
  Data
  - *All available data*
    - *Location and type information (i.e., fire ratings, special construction types, etc.). This allows the designer to locate ducts and fittings appropriately.*
- *IfcCeiling*
  Data
  - *Ceiling Type information*
    - *Information needed to determine where duct and fittings can be located.*
- *IfcBeam*
  Data
  - *Type, size and location of beams*
    - *This information is needed to prevent conflicts between beams and ducts and fittings.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.1.1.3. Sizing the Duct and Fittings

The sizes of the duct and fittings are calculated.

Input Information:

· *Pset_HVACSpaceElementInformation*
· *Pset_DuctSystemDesignCriteria*
· *Pset_DuctDesignCriteria*

Output Information:

· *Pset_CoordinationRequirement*
· *Pset_RectangularDuctConnection*
· *Pset_RoundDuctConnection*
· *Pset_OvalDuctConnection*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *Pset_HVACSpaceElementInformation*
  Data
  - *MaximumAirflow and MinimumAirflow values calculated from the room or space load calculations.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.1.1.4. Locate Other System Components

Identify and locate other system components required for the duct system.

Input Information:

· *Pset_DuctSystemDesignCriteria*
· *Pset_DuctDesignCriteria*
· *IfcWall*

Output Information:

· *Pset_CoordinationRequirement*
· *IfcDamper*
· *IfcPathwayElement*
· *IfcControlElement*
· *IfcActuator*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *IfcWall*

  Data

  - *All available data*
    - *Location and type information (i.e., fire ratings, special construction types, etc.). This allows the designer to identify locations for system components such as fire dampers.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.1.1.5. Interference Check

Identify any interferences with other trades.

Input Information:

· *Plumbing/Sprinkler plans*
· *Piping plans*
· *Floor plans*
· *Ceiling grid plans*
· *Reflected ceiling plans*
· *Lighting plans*
· *Power plans*
· *Structural plans*
· *Pset_CoordinationRequirement*

Output Information:

· *Pset_CoordinationRequirement*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *IfcWall*

  Data

  - *All available data*
    - *Location and type information (i.e., fire ratings, special construction types, etc.). This allows the designer to identify conflicts between walls and the duct system.*

- *IfcBeam*

  Data

- *Type, size and location of beams*
  - *This information is needed to prevent conflicts with air terminals, terminal boxes, duct, fittings, and equipment.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.1.1.6. Identify alternatives to design problems

This step requires the designer to go back and redesign certain portions of the system. This may involve regenerating the schematic design documents and recalculating system component sizes. Note that this step may occur at any point in the process.

Input Information:

· *Pset_CoordinationRequirement*

Output Information:

· *Pset_CoordinationRequirement*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *None.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.1.1.7. Pressure Loss Calculations

Determine the system pressure losses based on the duct system that has been designed.

Input Information:

· *Pset_DuctSystemDesignCriteria*
· *Pset_DuctDesignCriteria*

Output Information:

· *Pset_Fan, Pset_PackagedACUnit*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *Pset_Fan, Pset_PackagedACUnit*

  Data
  - *All available data*
    - *Pressure loss performance requirements for the fan or packaged AC unit*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.1.1.8. Fan Selection

Identify a fan that will appropriately meet the requirements of the duct system.

Input Information:

· *Pset_DuctSystemDesignCriteria*
· *Pset_HVACAirSideSystemDesignCriteria*

Output Information:

- *Pset_CoordinationRequirement*
- *IfcEquipment*
- *Pset_Fan, Pset_PackagedACUnit*
- *Pset_ElectricalCharacteristics*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *Pset_HVACAirSideSystemDesignCriteria*
  Data
  - *All available data.*
    - *This information is updated appropriately as the fan system is sized.*
- *IfcEquipment*
  Data
  - *All available data.*
    - *The information related to the weight and maintenance requirements is updated based on the fan selection.*
- *Pset_Fan, Pset_PackagedACUnit*
  Data
  - *All available data.*
    - *The information related to the fan or packaged unit is updated with the new performance data from the fan selection.*
- *Pset_ElectricalCharacteristics*
  Data
  - *All available data.*
    - *The electrical requirements for the selected fan or packaged AC unit.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.1.1.9. Generate Final System Representation

This step involves preparing drawings and specifications which will be used as contract documents for bid and construction. These documents complete the design phase of the system.

Input Information:

- *Pset_CoordinationRequirement*

Output Information:

- *Pset_AirTerminal*
- *Pset_TerminalBox*
- *Pset_DuctFitting*
- *Pset_DuctSegment*
- *IfcDamper*
- *IfcPathwayElement*
- *IfcControlElement*
- *IfcActuator*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *None.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.1.2. IFC Model Impact

Usage/Extensions to R1.5.1 object types and property sets

- *Pset_AirHandlingUnit*

  Data

  - *To be determined*

- *Pset_HVACAirSideSystemInformation*

  Data

  - *Need to coordinate with duct system design*

- *Pset_Fan*

  Data

  - *To be determined*

- *Pset_Insulation*

  Data

  - *Need to coordinate with duct and pipe insulation*

- *IfcEquipment*

  Data

  - *Need to reconcile relationship with IfcPathwayElement to allow for connectivity*

New object types and property sets required in R2.0

- *IfcPathwayElement*

  IfcPathwayElement generically connects together parts of a networked system. A networked system can be used to represent a system used to transport fluids, such as a duct or piping system. It can also be used for many other system representations, such as electrical distribution systems, computer networks, etc. Note that some types of pathway elements are part of more than one networked system. For example, a fan powered terminal box participates as part of a duct system as well as an electrical system.

  IfcPathwayElement is a subtype of IfcBuildingElement. This class provides a reference to a PathwayElementType type definition which contains the attributes required for the system being designed. In this manner, a pathway element can have properties of a channel (one input and one output), a junction (many inputs and one output) or a splitter (one input and many outputs).

  NOTE to Modeling Team: The following paragraph is reflective of IFC 1.0 constructs and does not incorporate the IfcNetwork constructs planned for the IFC Release 2.0 Core Model.

  The I_PhysicalConnections interface on IfcElement (from which IfcBuildingElement derives) contains the ConnectionPoints and PointConnections attributes which can be used for collecting physical or logical connections for both nodes and edges. ConnectionPoints can be used to collect pure logical connection points. PointConnections, combined with the information in a connection type property set (i.e., Pset_RectangularDuctConnection, Pset_RoundDuctConnection, Pset_OvalDuctConnection) attached to the referenced IfcPointConnector, provide the required information for the type, size and location of physical connections.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_RectangularDuctConnection*

This property set provides size information about a rectangular duct connection.

Data

- *See the Object Type Definition Tables section for details.*

- *Pset_RoundDuctConnection*

  This property set provides size information about a round duct connection.

  Data

  - *See Object Type Definition Tables for details*

- *Pset_OvalDuctConnection*

  This property set provides size information about an oval duct connection.

  Data

  - *See Object Type Definition Tables for details*

- *Pset_CoordinationRequirement*

  This property set provides a placeholder for interoperable coordination requirements between different disciplines.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_AirTerminal*

  This property set will be used by an IfcPathwayElement object for defining Air Terminals.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_TerminalBox*

  This property set will be used by an IfcPathwayElement object to define Terminal Boxes.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_DuctFitting*

  This property set will be used by an IfcPathwayElement object to define duct fittings.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_DuctSegment*

  This property set will be used by an IfcPathwayElement object to define duct segments.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_DuctDesignCriteria:*

  This property set will typically be used in conjunction with Pset_Fluid and Pset_Insulation.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_DuctSystemDesignCriteria:*

  This property set will typically be used in conjunction with Pset_Fluid and Pset_Insulation.

  Data

  - *See the Object Type Definition Tables section for details.*

- *IfcDamper:*

  This object class is a subtype of IfcPathwayElement and is used to define dampers.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_FireDamper:*

  This property set adds information to an IfcDamper object that is specific to fire dampers.

  Data
  - *See the Object Type Definition Tables section for details.*

- *Pset_SmokeDamper:*

  This property set adds information to an IfcDamper object that is specific to smoke dampers.

  Data
  - *See the Object Type Definition Tables section for details.*

- *Pset_FireSmokeDamper:*

  This property set adds information to an IfcDamper object that is specific to combination fire and smoke dampers.

  Data
  - *See the Object Type Definition Tables section for details.*

- *Pset_BackdraftDamper:*

  This property set adds information to an IfcDamper object that is specific to backdraft dampers.

  Data
  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlDamper:*

  This property set adds information to an IfcDamper object that is specific to control dampers.

  Data
  - *See the Object Type Definition Tables section for details.*

- *Pset_Louver:*

  This property set adds information to an IfcDamper object that is specific to louvers.

  Data
  - *See the Object Type Definition Tables section for details.*

- *IfcControlElement*

  This class is used to identify control components that are typically a part of any HVAC duct or piping system. The information contained within this class and its related property sets attempt to remain consistent with the BACnet Standard. This allows implementation of the IFC control elements to be compatible with the BACnet Standard as desired.

  BACnet is a very extensive, but not exhaustive specification aimed at providing an interoperable method of generalized Building Control Systems from different vendors. It does provide an object specification, some of which has been integrated into IFC.

  To determine the suitability of the BACnet object attributes required for inclusion in IFC, the BACnet object attributes were categorized into three major groups by the IAI Building Systems domain committee:

  - *External -- Provided by the consultant, design engineer or owner. These are the attributes to be included in the IFC specifications.*
  - *Vendor -- Specifics that depend upon the product offering of the control vendor and the vendor's engineering efforts*
  - *Run-Time – The actual values of the building and systems when under control (values altered by operating staff are considered run-time, not externally specified)*

  The reader is reminded that BACnet is a communication protocol. It is not a database for a building control system, but rather formalized method of communication.

  In order to provide IFC interoperability, the externally specified attributes of the BACnet Objects should be standardized so that design engineers can communicate their *requirements to control vendors. All other uses and definitions of the BACnet attributes are defined in the BACnet Specification (ANSI/ASHRAE 135-95).*

Data

- *See the Object Type Definition Tables section for details.*

- *IfcActuator*

  This object class subtypes from IfcControlElement to define the various types of actuators.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_LinearActuator*

  This property set adds information to an IfcActuator object that is specific to linear actuators.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_RotationalActuator*

  This property set adds information to an IfcActuator object that is specific to linear actuators.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ElectricActuator*

  This property set adds information to an IfcActuator object that is specific to electric actuators.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_PneumaticActuator*

  This property set adds information to an IfcActuator object that is specific to pneumatic actuators.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_HydraulicActuator*

  This property set adds information to an IfcActuator object that is specific to hydraulic actuators.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_HandOperatedActuator*

  This property set adds information to an IfcActuator object that is specific to hand operated actuators.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_Sensor*

  This property set adds information to an IfcControlElement object that is specific to sensors.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_Controller*

  This property set adds information to an IfcControlElement object that is specific to sensors.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementAnalogInput*

This property set adds information to an IfcControlElement object that has an analog input. This is a BACnet compatible property set.

Data

- *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementAnalogOutput*

  This property set adds information to an IfcControlElement object that has an analog output. This is a BACnet compatible property set.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementBinaryInput*

  This property set adds information to an IfcControlElement object that has a binary input. This is a BACnet compatible property set.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementBinaryOutput*

  This property set adds information to an IfcControlElement object that has a binary output. This is a BACnet compatible property set.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementMultiStateInput*

  This property set adds information to an IfcControlElement object that has a multi-state input. This is a BACnet compatible property set.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementMultiStateOutput*

  This property set adds information to an IfcControlElement object that has a multi-state output. This is a BACnet compatible property set.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementEventEnrollment*

  This property set adds information to an IfcControlElement object regarding the events that the object participates with. This is a BACnet compatible property set.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementLoop*

  This property set adds information to an IfcControlElement object about the control loop that the object participates with. This is a BACnet compatible property set.

  Data

  - *See the Object Type Definition Tables section for details.*

5.3.1.3. RoadMap Issues

Interoperability Value

Disciplines/Applications from which information is needed:

- *Architectural*
- *Structural*

- *HVAC (Piping plans, thermal loads)*
- *Plumbing/Fire Protection*
- *Electrical*
- *Lighting*

Disciplines/Applications to which information will be supplied:

- *Electrical*
- *HVAC*
- *Plumbing/Fire Protection*
- *Structural*

Value of software supporting this process

In this section, other domain teams will rank the value of software which supports this process, based on IFC.

- *Architecture (7)*
- *Building Services (8)*
- *HVAC (9)*
- *FM (6)*
- *CM/Cost (8)*

Sponsor Software Companies

The following software companies have shown interest in developing applications which implement the process

- *APEC*
- *Carrier*
- *Greenheck*
- *Honeywell*
- *Landis-Staefa*

5.3.1.4. Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues

Proposed resolution

- {{ Issue 1 }}
    - {{ Proposed resolution }}
- {{ Issue 2 }}
    - {{ Proposed resolution }}

5.3.2. Process: HVAC Piping System Design

HVAC Piping System Design supports the design and representation of piping systems. These processes are typically performed by engineers and design-build contractors during the design phase of a building or project, prior to construction. The process culminates with a set of drawings which can be bid upon and constructed.

This section defines the specific requirements for HVAC Piping System Design based on the generalized Building Services System Design described above.

5.3.2.1. Information Analysis by Task

Please see the process overview description, process diagram and detailed process definition for this process in the "AEC+FM Industry Process Definitions" section of this document.

5.3.2.1.1. Select and Locate System Components

This step involves selecting and locating the air terminals, boxes (if included in the design), and fans that compose the HVAC duct system.

Input Information:

- *Floor plans*
- *Ceiling grid plans*
- *Reflected ceiling plans*
- *Lighting plans*
- *Structural plans*
- *Sprinkler plans*
- *Piping plans*
- *Smoke detector plans*
- *Speaker plans*

Output Information:

- *Pset_AirTerminal*
- *Pset_CoordinationRequirement*
- *Pset_TerminalBox*
- *IfcPathwayElement*
- *IfcEquipment*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *IfcWall*

  Data

  - *All available data*
    - *Location and type information (i.e., fire ratings, special construction types, etc.). This allows the designer to identify the potential locations for air terminals, boxes and fans*

- *IfcSpace*

  Data

  - *Programme information*
    - *Information specific to the intended function of the space, which is used to determine the number and type of air terminals to be installed.*

- *IfcCeiling*

  Data

  - *Ceiling Type information*
    - *Information needed to determine the type and location of air terminals to be installed.*
    - *Information needed to determine clearances in interstitial spaces.*

- *IfcBeam*

  Data

  - *Type, size and location of beams*
    - *This information is needed to prevent conflicts with air terminals and terminal boxes.*

- *IfcFluidMover*

  Data

  - *All available data.*

- *This information coupled with the Pset_Fan or Pset_AirHandlingUnit property sets are used to locate and initially specify the fan.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.2.1.2. Connect Components with Ducts and Fittings

This step involves using engineering judgment to connect the air terminals, boxes, and fans with ducts and fittings. This information is then used for preparing drawings or specifications which will schematically represent the system under design. These schematics are then used to begin coordination with other disciplines which are impacted by the system.

Input Information:

- *Floor plans*
- *Structural plans*
- *Pset_CoordinationRequirement*

Output Information:

- *Pset_DuctFitting*
- *Pset_DuctSegment*
- *IfcPathwayElement*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *IfcWall*
  - ***Data***
  - *All available data*
    - *Location and type information (i.e., fire ratings, special construction types, etc.). This allows the designer to locate ducts and fittings appropriately.*
- *IfcCeiling*
  - ***Data***
  - *Ceiling Type information*
    - *Information needed to determine where duct and fittings can be located.*
- *IfcBeam*
  - ***Data***
  - *Type, size and location of beams*
    - *This information is needed to prevent conflicts between beams and ducts and fittings.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.2.1.3. Sizing the Duct and Fittings

The sizes of the duct and fittings are calculated.

Input Information:

- *Pset_HVACSpaceElementInformation*
- *Pset_DuctSystemDesignCriteria*
- *Pset_DuctDesignCriteria*

Output Information:

- *Pset_CoordinationRequirement*
- *Pset_RectangularDuctConnection*
- *Pset_RoundDuctConnection*

- *Pset_OvalDuctConnection*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *Pset_HVACSpaceElementInformation*
  Data
  - *MaximumAirflow and MinimumAirflow values calculated from the room or space load calculations.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.2.1.4. Locate Other System Components

Identify and locate other system components required for the duct system.

Input Information:

- *Pset_DuctSystemDesignCriteria*
- *Pset_DuctDesignCriteria*
- *IfcWall*

Output Information:

- *Pset_CoordinationRequirement*
- *IfcDamper*
- *IfcPathwayElement*
- *IfcControlElement*
- *IfcActuator*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *IfcWall*
  Data
  - *All available data*
    - *Location and type information (i.e., fire ratings, special construction types, etc.). This allows the designer to identify locations for system components such as fire dampers.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.2.1.5. Interference Check

Identify any interferences with other trades.

Input Information:

- *Plumbing/Sprinkler plans*
- *Piping plans*
- *Floor plans*
- *Ceiling grid plans*
- *Reflected ceiling plans*
- *Lighting plans*
- *Power plans*
- *Structural plans*
- *Pset_CoordinationRequirement*

Output Information:

· *Pset_CoordinationRequirement*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *IfcWall*

  Data

  - *All available data*
    - *Location and type information (i.e., fire ratings, special construction types, etc.). This allows the designer to identify conflicts between walls and the duct system.*

- *IfcBeam*

  Data

  - *Type, size and location of beams*
    - *This information is needed to prevent conflicts with air terminals, terminal boxes, duct, fittings, and equipment.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.2.1.6. Identify alternatives to design problems

This step requires the designer to go back and redesign certain portions of the system. This may involve regenerating the schematic design documents and recalculating system component sizes. Note that this step may occur at any point in the process.

Input Information:

· *Pset_CoordinationRequirement*

Output Information:

· *Pset_CoordinationRequirement*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *None.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.2.1.7. Pressure Loss Calculations

Determine the system pressure losses based on the duct system that has been designed.

Input Information:

· *Pset_DuctSystemDesignCriteria*
· *Pset_DuctDesignCriteria*

Output Information:

· *Pset_Fan, Pset_PackagedACUnit*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *Pset_Fan, Pset_PackagedACUnit*

  Data

- *All available data*
    - *Pressure loss performance requirements for the fan or packaged AC unit*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.2.1.8. Fan Selection

Identify a fan that will appropriately meet the requirements of the duct system.

Input Information:

· *Pset_DuctSystemDesignCriteria*
· *Pset_HVACAirSideSystemDesignCriteria*

Output Information:

· *Pset_CoordinationRequirement*
· *IfcEquipment*
· *Pset_Fan, Pset_PackagedACUnit*
· *Pset_ElectricalCharacteristics*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *Pset_HVACAirSideSystemDesignCriteria*

  Data
  - *All available data.*
    - *This information is updated appropriately as the fan system is sized.*

- *IfcEquipment*

  Data
  - *All available data.*
    - *The information related to the weight and maintenance requirements is updated based on the fan selection.*

- *Pset_Fan, Pset_PackagedACUnit*

  Data
  - *All available data.*
    - *The information related to the fan or packaged unit is updated with the new performance data from the fan selection.*

- *Pset_ElectricalCharacteristics*

  Data
  - *All available data.*
    - *The electrical requirements for the selected fan or packaged AC unit.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.2.1.9. Generate Final System Representation

This step involves preparing drawings and specifications which will be used as contract documents for bid and construction. These documents complete the design phase of the system.

Input Information:

· *Pset_CoordinationRequirement*

Output Information:

· *Pset_AirTerminal*

- *Pset_TerminalBox*
- *Pset_DuctFitting*
- *Pset_DuctSegment*
- *IfcDamper*
- *IfcPathwayElement*
- *IfcControlElement*
- *IfcActuator*

Project Model Usage Requirements:

Object types existing in R1.5.1:

- *None.*

Object types to add in R2.0:

See the IFC Model Impact section for class details.

5.3.2.2. IFC Model Impact

Usage/Extensions to R1.5.1 object types and property sets

- *Pset_AirHandlingUnit*

  Data

  - *To be determined*

- *Pset_HVACAirSideSystemInformation*

  Data

  - *Need to coordinate with duct system design*

- *Pset_Fan*

  Data

  - *To be determined*

- *Pset_Insulation*

  Data

  - *Need to coordinate with duct and pipe insulation*

- *IfcEquipment*

  Data

  - *Need to reconcile relationship with IfcPathwayElement to allow for connectivity*

New object types and property sets required in IFC R2.0

- *IfcPathwayElement*

  IfcPathwayElement generically connects together parts of a networked system. A networked system can be used to represent a system used to transport fluids, such as a duct or piping system. It can also be used for many other system representations, such as electrical distribution systems, computer networks, etc. Note that some types of pathway elements are part of more than one networked system. For example, a fan powered terminal box participates as part of a duct system as well as an electrical system.

  IfcPathwayElement is a subtype of IfcBuildingElement. This class provides a reference to a PathwayElementType type definition which contains the attributes required for the system being designed. In this manner, a pathway element can have properties of a channel (one input and one output), a junction (many inputs and one output) or a splitter (one input and many outputs).

NOTE to Modeling Team: The following paragraph is reflective of IFC 1.0 constructs and does not incorporate the IfcNetwork constructs planned for the IFC Release 2.0 Core Model.

The I_PhysicalConnections interface on IfcElement (from which IfcBuildingElement derives) contains the ConnectionPoints and PointConnections attributes which can be used for collecting physical or logical connections for both nodes and edges. ConnectionPoints can be used to collect pure logical connection points. PointConnections, combined with the information in a connection type property set (i.e., Pset_RectangularDuctConnection, Pset_RoundDuctConnection, Pset_OvalDuctConnection) attached to the referenced IfcPointConnector, provide the required information for the type, size and location of physical connections.

Data

- *See the Object Type Definition Tables section for details.*

- *Pset_RectangularDuctConnection*

  This property set provides size information about a rectangular duct connection.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_RoundDuctConnection*

  This property set provides size information about a round duct connection.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_OvalDuctConnection*

  This property set provides size information about an oval duct connection.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_CoordinationRequirement*

  This property set provides a placeholder for interoperable coordination requirements between different disciplines.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_AirTerminal*

  This property set will be used by an IfcPathwayElement object for defining Air Terminals.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_TerminalBox*

  This property set will be used by an IfcPathwayElement object to define Terminal Boxes.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_DuctFitting*

  This property set will be used by an IfcPathwayElement object to define duct fittings.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_DuctSegment*

  This property set will be used by an IfcPathwayElement object to define duct segments.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_DuctDesignCriteria:*

This property set will typically be used in conjunction with Pset_Fluid and Pset_Insulation.

Data

- *See the Object Type Definition Tables section for details.*

- *Pset_DuctSystemDesignCriteria:*

  This property set will typically be used in conjunction with Pset_Fluid and Pset_Insulation.

  Data

  - *See the Object Type Definition Tables section for details.*

- *IfcDamper:*

  This object class is a subtype of IfcPathwayElement and is used to define dampers.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_FireDamper:*

  This property set adds information to an IfcDamper object that is specific to fire dampers.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_SmokeDamper:*

  This property set adds information to an IfcDamper object that is specific to smoke dampers.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_FireSmokeDamper:*

  This property set adds information to an IfcDamper object that is specific to combination fire and smoke dampers.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_BackdraftDamper:*

  This property set adds information to an IfcDamper object that is specific to backdraft dampers.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlDamper:*

  This property set adds information to an IfcDamper object that is specific to control dampers.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_Louver:*

  This property set adds information to an IfcDamper object that is specific to louvers.

  Data

  - *See the Object Type Definition Tables section for details.*

- *IfcControlElement*

  This class is used to identify control components that are typically a part of any HVAC duct or piping system. The information contained within this class and its related property sets attempt to remain consistent with the BACnet Standard. This allows implementation of the IFC control elements to be compatible with the BACnet Standard as desired.

  BACnet is a very extensive, but not exhaustive specification aimed at providing an interoperable method of generalized Building Control Systems from different vendors. It does provide an object specification, some of which has been integrated into IFC.

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Vendor -- Specifics that depend upon the product offering of the control vendor and the vendor's engineering efforts

Run-Time – The actual values of the building and systems when under control (values altered by operating staff are considered run-time, not externally specified)

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Data

- *See the Object Type Definition Tables section for details.*

- *IfcActuator*

  This object class subtypes from IfcControlElement to define the various types of actuators.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_LinearActuator*

  This property set adds information to an IfcActuator object that is specific to linear actuators.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_RotationalActuator*

  This property set adds information to an IfcActuator object that is specific to linear actuators.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ElectricActuator*

  This property set adds information to an IfcActuator object that is specific to electric actuators.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_PneumaticActuator*

  This property set adds information to an IfcActuator object that is specific to pneumatic actuators.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_HydraulicActuator*

  This property set adds information to an IfcActuator object that is specific to hydraulic actuators.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_HandOperatedActuator*

This property set adds information to an IfcActuator object that is specific to hand operated actuators.

Data

- *See the Object Type Definition Tables section for details.*

- *Pset_Sensor*

  This property set adds information to an IfcControlElement object that is specific to sensors.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_Controller*

  This property set adds information to an IfcControlElement object that is specific to sensors.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementAnalogInput*

  This property set adds information to an IfcControlElement object that has an analog input. This is a BACnet compatible property set.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementAnalogOutput*

  This property set adds information to an IfcControlElement object that has an analog output. This is a BACnet compatible property set.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementBinaryInput*

  This property set adds information to an IfcControlElement object that has a binary input. This is a BACnet compatible property set.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementBinaryOutput*

  This property set adds information to an IfcControlElement object that has a binary output. This is a BACnet compatible property set.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementMultiStateInput*

  This property set adds information to an IfcControlElement object that has a multi-state input. This is a BACnet compatible property set.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementMultiStateOutput*

  This property set adds information to an IfcControlElement object that has a multi-state output. This is a BACnet compatible property set.

  Data

  - *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementEventEnrollment*

  This property set adds information to an IfcControlElement object regarding the events that the object participates with. This is a BACnet compatible property set.

Data

- *See the Object Type Definition Tables section for details.*

- *Pset_ControlElementLoop*

  This property set adds information to an IfcControlElement object about the control loop that the object participates with. This is a BACnet compatible property set.

  Data

  - *See the Object Type Definition Tables section for details.*

5.3.2.3. RoadMap Issues

Interoperability Value

Disciplines/Applications from which information is needed:

- *Architectural*
- *Structural*
- *HVAC*
- *Plumbing/Fire Protection*
- *Electrical*

Disciplines/Applications to which information will be supplied:

- *Electrical*
- *HVAC*
- *Plumbing/Fire Protection*
- *Structural*

Value of software supporting this process

In this section, other domain teams will rank the value of software which supports this process, based on IFC.

- *Architecture (7)*
- *Building Services (8)*
- *HVAC (9)*
- *FM (6)*
- *CM/Cost (8)*

Sponsor Software Companies

The following software companies have shown interest in developing applications which implement the process

- *APEC*
- *Carrier*
- *Greenheck*
- *Honeywell*
- *Landis-Staefa*

5.3.2.4. Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues

Proposed resolution

- {{ Issue 1 }}
  - {{ Proposed resolution }}
- {{ Issue 2 }}
  - {{ Proposed resolution }}

5.4. [BS-3] Pathway Design and Coordination

5.4.1. Process: Pathway Design and Coordination

The design of pathways contains the draft layout, the coordination and the representation of mechanical and electrical system-pathways to be installed.

This design process is carried out after the first coordination with the architect and structural engineers, and includes load estimates, energy and systems definitions required for a building.

The process ends with drawings containing the coordinated pathways for the mechanical and electrical installations (i.e. heating, cooling, air-conditioning, plumbing, fire-protection and electrical power) within a building.

Based on the building model and the conditions (program) defined by the customer, an initial estimate of required energy, technical equipment and systems is defined. The process of designing the pathway starts by defining the required spatial extents for technical equipment, piping, ducting and electrical routes.

A rough building layout by the architect will frequently be available showing the suggested locations for plant rooms and risers.

Considering these parameters, the engineer defines the necessary locations for plant areas and suggests the routing of the main pathways.

The required plant area and main pathways are represented in the M & E drawings.

This draft is presented to the architect/customer with details on space requirements (sections). Thereafter, a review of the suggested design solution will take place, taking into account the structure, the initial and future investment, user requirements, operating expenses and the flexibility achieved.

Parameters from the building model, the definition of systems and the routes of each media type can be combined to define the pathway. Air ducts, including equipment (fire dampers, VAV-boxes, etc.) are combined to form a ventilation pathway. Pipes for heating, cooling or plumbing are combined to form a media pathway. Electrical trays are combined to form an electrical pathway. Each pathway should allow variables for necessary insulation or fire proofing, as well as variables for necessary access for installation and maintenance. The optimization of the pathway itself can be done by varying the distance and position of ducts, pipes or trays. Every pathway must be coordinated within the architectural and structural restraints, as well as with each other.

A final definition of the spatial requirements for technical equipment and media distribution, defines the location of the pathway. The translation of the pathway into geometrical forms is carried out. These drawings serve as a guideline for the ongoing building services design.

The definitions of the structural systems (flat slab, concrete or steel construction, beams, etc.) reflect the location of the plant areas, risers and pathways. Collision detection with walls, slabs, binding beams etc. should be made and openings have to be defined.

5.4.1.1. Information Analysis by Task

Please see the process overview description, process diagram and detailed process definition for this process in the "AEC+FM Industry Process Definitions" section of this document.

5.4.1.1.1. Task A - Defining required space for stations

This step contains the dimensioning of main components for different systems, inquiry of the approximate space requirement and corresponding placing of the technical areas in the building model. See also - description in the Process definition section above.

Input Information:

- *system design criteria*
- *building model from architect*
- *load calculations and media/system type*
- *preliminary systems definition*
- *other requests like accessibility, flexibility, installation, maintenance*
- *coordination with client*

Output Information:

- *needed plant area and room for the central supply*
- *placing of the central supply in the building*

5.4.1.1.2. Task B - Defining the required space for pathways

This step contains the dimensioning of the energy and media supply as well as the specification of *pathway.* See also - description in the Process definition section above.

Input Information:

- *system design criteria*
- *building model from architect*
- *loads and required medium*
- *appropriate system*
- *other items like accessibility, insulation, fire proofing, installation*

Output Information:

- *required area or volume of pathway*

5.4.1.1.3. Task C - Geometrical representation of stations and pathways

This step contains the geometrical representation of the defined centralized media supply and pathway. See also - description in the Process definition section above.

Input Information:

- *areas for technical plant equipment*
- *placement of plant equipment*
- *space requirement of pathway*

Output Information:

- *building model with geometrical representation of technical plant equipment and pathways.*

5.4.1.1.4. Task D - Interference check

Collision detection with other technical services and the building model . See also - description in the Process definition section above.

Input Information:

- *building model with geometrical representation of technical plant equipment and pathways*
- *coordination requirement*

Output Information:
- *coordination requirement*

5.4.1.1.5. Task E - Identify alternatives to resolve the collisions

This step requires the designer to go back and redesign certain portions of the system. This may involve regenerating the schematic design documents and recalculating system component. Note that this step may occur at any point in the process. See also - description in the Process definition section above.

Input Information:
- *coordination requirement*

Output Information:
- *geometrical representation of pathway*

5.4.1.1.6. Task F - Itemization of Pathway

This step contains the detailed output of a pathway. By consideration of departures and branching as well as the location and distance of each pipe or duct the cross-sectional dimension of the pathway is brought into line with the respective conditions and will be optimized. See also - description in the Process definition section above.

Input Information:
- *coordination requirement*
- *thermal load calculations*
- *building model from architect*

Output Information:
- *geometrical representation of pathway*
- *coordination requirement*

5.4.1.1.7. Task G - Coordination of branches

This step contains the coordination of different trades within the design of pathway at branchings as well as the coordination with structural conditions like binding beams etc. See also - description in the Process definition section above.

Input Information:
- *geometrical representation of pathway*
- *coordination requirement*
- *building model from architect*

Output Information:
- *coordinated allocation scheme of pathway*

5.4.1.1.8. Task H - Interference check

Collision detection with other disciplines and building model . See also - description in the Process definition section above.

Input Information:
- *building model geometrical representation of technical facilities and pathways*
- *cost estimating and operating expanses for HVAC-Systems*
- *building model*
- *coordination requirement*

Output Information:
- *coordination requirement*

5.4.1.1.9. Task I - Determination of openings

This step contains the specification of openings. See also - description in the Process definition section above.

Input Information:
- *coordination requirement*
- *geometrical representation of pathway*

Output Information:
- *coordination requirement*
- *size and placement*

5.4.1.1.10. Task J - Generate final system

This step contains the design of drawings or specifications which are used as a basis for further systems design. See also - description in the Process definition section above.

Input Information:
- *coordination required*

Output Information:
- *see definitions of objects and attributes of*
  - *AR-1 Completion of Architectural Model*
  - *BS-1 HVAC System Design*
  - *BS-2 Power and Lighting Systems Design*
  - *ST-1 Steel Frame Structures*
  - *ST-2 Reinforced Concrete Structures*

5.4.1.2. IFC Model Impact

This section summarizes the model requirements from all the process tasks analyzed above into two groups Extensions to R1.5.1 model object types and proposed new object types for R2.0.

Extensions to existing R1.5.1 Object Types

The coordination of the pathways deals with existing definitions of objects and attributes in the following projects :

- *AR-1 Completion of Architectural Model*
- *BS-1 HVAC System Design*
- *BS-2 Power and Lighting Systems Design*
- *ST-1 Steel Frame Structures*
- *ST-2 Reinforced Concrete Structures*

The basic information as well as the results of the coordination take effect in the processes listed above. For further information please refer to these documents.

New object types required in IFC R2.0

- *None defined*

5.4.1.3. RoadMap Issues

Interoperability Value

Disciplines/Applications from which information is needed:

- *Architectural*

- *Structural*
- *HVAC*
- *Plumbing / Fire Protection*
- *Electrical*
- *Lighting*

Disciplines/Applications to which information will be supplied:

- *Architectural*
- *Structural*
- *HVAC*
- *Plumbing / Fire Protection*
- *Electrical*
- *Lighting*
- *Cost Estimating*
- *Facility Management*

Value of software supporting this process

In this section, other domain teams will rank the value of software which supports this process, based on IFC.

- *Note assessed*

Sponsor Software Companies

The following software companies have shown interest in developing applications which implement the process

- *RoCAD Informatik*
- *PHi-Tech*
- *GTS*
- *'ESS*
- *Ziegler Informatics*
- *RoCAD Informatik*
- *Triplan GmbH*
- *Pit-cup GmbH*

5.4.1.4. Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues

Proposed resolution

- {{ Issue 1 }}
  - {{ Proposed resolution }}
- {{ Issue 2 }}
  - {{ Proposed resolution }}

5.5. [BS-4] HVAC Loads Calculation

5.5.1. Process: Building Heating and Cooling Load Calculation

Load calculations serve as the basis for all design stages of the building services design. The results of the load calculations enable the designer to dimension the plant equipment and to determine the required space for plant room.

Load calculations are an official proofing method in Germany for example the proof for heat loss protection must be given in the course of a project), a mode for calculating the heating cooling load or for the yearly dynamic load simulation:

The process terminates in the complete calculations and the data exchange into the IFC model.

The chapter on hand defines the prerequisites for the computer-aided load calculation using of the thermal building model (refer to VDI Guideline 6021, green paper).

After the completion of the building model with its geometric and physical building specifications by the architect, the data is to be extracted using the Aspect Model Load Calculations -- The Thermal Building Model. The thermal building model includes all architectural building components of a defined room, the attributes and the relationships of the components to each other. The thermal building model does not include any the description of the neighboring buildings (e.g. input for external shading).

The parameters like the room temperatures, required air changes, people or machine loads or other necessary data is submitted if known to the design team. If certain data is not know to the design team plausible data is assumed to provide preliminary answers.

The data exchange to the thermal building model does not require any exchange of the graphical data. The thermal building model is independent from the calculation method applied because it describes only the physical data.

After the exchange of data, the engineer checks data transmitted for completeness and possibly amend the data. The engineer has to input the boundary conditions as well as the meteorological data for the load calculation method.

The definition of zones, as a result of the assigned plant equipment, can be carried out by simply numbering them. All rooms of one level having common boundaries can be defined as one zone. Another form of zoning can be made by direct plant assignment. This method ensures, that considerations of energy as well as the simultaneity of use conditions within plants are considered.

As a results of load calculations, the physical qualities of building components may be changed and submitted to an optimization process. This is requested to the IFC-building model. After changing the corresponding data a further exchange of basic data is carried out and the process starts once more.

A revision phase is necessary if there is change to the plant assignment or there are variations to the boundary conditions within the process.

At the end of the process the results of the load calculations are provided for the IFC model for further processing. The definition of technical stations, pathway and their space requirements as well as the dimensioning of system components for building services design are based on these results.

5.5.1.1. Information Analysis by Task

Please see the process overview description, process diagram and detailed process definition for this process in the "AEC+FM Industry Process Definitions" section of this document.

5.5.1.1.1. Task A - IFC-Model take-over

This step contains the import of extracted data from the building model like component geometry and component qualities. The construction of this physical data exchange format corresponds in the construction to a Physical-STEP file. See also - description in the Process definition section above.

Input Information:

- *All structural components of a room, referring to the aspect model of the Thermal Building Model*
- *All component parameters of the structural components (thermal storage)*
- *The relationship of structural components with each other or the outside area.*
- *Alternatively usage conditions*

Output Information:

- *Preparation of data*

5.5.1.1.2. Task B - Specification of zones

See also - description in the Process definition section above.

Input Information:

- *Building geometry*
- *Use conditions*
- *Plant assignment*

Output Information:

- *Preparation of data*

5.5.1.1.3. Load calculations

This step contains the execution of the load calculations. See also - description in the Process definition section above.

Input Information:

- *Data from the thermal building model*
- *Data preparation and specification of zones*
- *Use conditions*
- *Meteorological and thermal boundary conditions*

Output Information:

- *Room-, zones-(plants-) and building wise load calculations as*
- *Energy consumption proof*
- *Heating load*
- *Cooling load*
- *Annual energy requirement*
- *Building simulation*
- *Requirements on the building*

5.5.1.1.4. Task D - Results into IFC-Model

Exchanging the results of the load calculations to the IFC model. See also - description in the Process definition section above.

Input Information:

- *Detailed load calculations*

Output Information:

- *Results of calculation in abridged version*

5.5.1.1.5. Task E - Design modifications

This step contains the iterative event for the execution of all calculations by variation or change of the zones, usage requirements etc., according to optimization by changing parameters. See also - description in the Process definition section above.

Input Information:

- *Change of zone division (plant assignment)*
- *Change of use conditions*

· *Change of boundary conditions*

Output Information:

· *Calculating variants*
· *New detailed load calculations*
· *New calculation results (requirements on the building model)*

5.5.1.2. IFC Model Impact

This section summarizes the model requirements from all the process tasks analyzed above into two groups Extensions to R1.5.1 model object types and proposed new object types for R2.0.

Extensions to existing R1.5.1 Object Types

- attributes	comments	
IfcProject		
- project short name (mark)	ProjectReference	IfcString
- project name		
- client		
- building service engineer		
- created by		
- revision number		
- comment		
IfcBuilding		
- referenced project	ref(project)	
- building short name		
- building name		
- ground touching floor area	m2	
- ground-level - NNG	m NN	
- building height - h	m	
IfcBuildingStorey		
- referenced building	ref(building)	
- storey short name		
- storey name		
- storey height (of floor construction)	m NN	

New object types required in IFC R2.0

- attributes	comments
IfcFunctionalUnit (Zone)	
- referenced building	ref(building)
- name of functional unit	
IfcRoom	
- referenced storey	ref(storey)
- referenced functional unit	ref(functional unit)
- room short name	
- room name	
- room temperature	oC
- not full conditioned	Y/N
- storey height for room	m
- room height	m

- *floor level (of floor finish)*	*m*
- *room perimeter*	*m*
- *room ground area*	*m2*
- *room volume*	*m3*

- *Structural Components (general Type)*

- *structure component type number (index)*	*unique human interpretable number*	
- *structure component type name*		
- *infiltration coefficient (Window)*		*m3/(mhPa2/3)*
- *airflow between layers*	*Y/N*	*NT*

- *Non Heat Storing Structural Components*

- *structural component number (index)*	*unique human interpretable number*
- *structural component type name*	
- *heat transmission coefficient*	*W/m2K*
- *radiation transmission coefficient - glazing*	*b-value*
- *grade of energy flow through the component*	
- *airflow through joints*	*m3/(hPa2/3)*

- *Heat Storing Structural Components*

- *structural component name*	
- *heat conducting coefficient*	*W/mK*
- *thickness of the layer*	*m*
- *density of the layer*	*kg/m3*
- *lower value of diffusion coefficient*	
- *upper value of diffusion coefficient*	
- *specific heat capacity of the layer*	*kJ/kgK*

- *Structural Components*

- *referenced type*	*ref(structural component type)*
- *structural component number*	
- *structural component orientation*	
- *from true north*	*in degree*
- *structural component slope*	*in degree*
- *structural component width*	*in m*
- *structural component height*	*in m*
- *structural component area*	*m2*

- *Specific - for Non Heat Storing Structural Components*

- *referenced type*	*ref(structural component type for non heat storing components)*
- *number of horizontal joints*	
- *number of vertical joints*	
- *length of all joints*	*m*
- *radiation transmission coefficient of the outside sun protection devices*	*b- value*
- *radiation transmission coefficient of the indoor sun protection devices*	*b- value*
- *window projection length b*	*in m*
- *window projection length d*	*in m*
- *window projection length f*	*in m*
- *window projection length c*	*in m*
- *glass area fraction*	

- *Room Usage Parameters*

- *referenced room*	*ref(room)*
- *usage unit*	*see below*
- *maximum value*	*see below*
- *usage grade*	*see below*
- *constant*	*Y/N*

- *value until 1 o'clock*	*%*
- *and so on*	*%*
- *value until 24 o'clock*	*%*

comment: the usage units are described in the following table:

- *usage unit*	*mark*	*maximum value using grade*	
- *persons*	*P*	*number activity (1,2,3)*	
- *lighting*	*B*	*W*	*room load factor*
- *machines*	*M*	*W*	*convective component*
- *air supply*	*ZU*	*temperature in oC*	
- *outside air*	*AU*	*mass flow in kg/s*	
- *air extraction*	*AB*	*temperature of the incoming air in oC*	
- *desired room temperature*	*RT*	*temperature in oC*	
- *air change rate*	*LW*	*1/ h*	
- *heat supply or removal*	*S*	*W*	

- *Room to Structural Component - Relation*

- *referenced structural component*	*ref(structural component)*
- *referenced room*	*ref(room)*
- *structural component index*	*predefined list of indices*
- *orientation*	*front or rear*

- *Additional information - FOR GERMANY ONLY*
- *GEB / WSV - building data according to DIN 4701 and WSchV´(heat loss regulation)*

- *referenced building*	*ref(building)*
- *building type*	*E = single house*
	R = multiple house
- *situation*	*N = normal*
- *F = free (windy)*	
- *kind of building*	*N = normal inside temperature*
	G = lower level inside temperature
- *building*	*as defined in WSchV*
- *building between others*	*Y/N*
- *relation l/b from floor slab areas*	*as defined in DIN 4701*

5.5.1.3. RoadMap Issues

Interoperability Value

Disciplines/Applications from which information is needed:

- *Architectural*

Disciplines/Applications to which information will be supplied:

- *HVAC Pathway Design and Coordination*
- *HVAC Duct System Design*
- *HVAC Hydronic System Design*
- *Cost Estimating*
- *Structural*
- *Architectural*

Value of software supporting this process

In this section, other domain teams will rank the value of software which supports this process, based on IFC. Values from 1-10, 1 being the lowest value, 10 being the highest value

- *Not assessed for this process*

Sponsor Software Companies

The following software companies have shown interest in developing applications which implement the process

- *None*

5.5.1.4. Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues

Proposed resolution

- {{ Issue 1 }}
  - {{ Proposed resolution }}
- {{ Issue 2 }}
  - {{ Proposed resolution }}

5.6. [CS-1] Code Checking - Energy Codes

5.6.1. Process: Commercial and Residential Energy Code Compliance Checking

5.6.1.1. Information Analysis by Task

Please see the process overview description, process diagram and detailed process definition for this process in the "AEC+FM Industry Process Definitions" section of this document.

The processes illustrated above will be employed in code checking applications that address the following codes:

1. ASHRAE/IESNA Standard 90.1-1989 (Std 90.1)
2. Model Energy Code (MEC - all recent years)

The specific tasks illustrated in the diagrams above are all embedded within existing widely-distributed applications.

5.6.1.1.1. All Tasks

See description in the Process definition section above.

The inputs and outputs of the individual process tasks are not generally shared with other applications and are too numerous to be conveniently listed as separate task inputs and outputs using this format. For now, they have simply be summarized for the entire process below. Use of existing classes has not been noted, except where new attributes are required. Because the product model usage requirements are not broken down by task, they are identical to IFC Model Impact section, and the information is shown once there. [This information is also shown in an accompanying spreadsheet table.]

Input Information:

- *Code Requirements*
- *Building Model*
- *Analysis Rules*

Output Information:

- *Object Constraints*
  - *IfcPropetyConstaints*
  - *IfcIntent*
- *IfcAgregateControl*
- *Code Violation Reports*
- *Compliance Performance Results*
- *Compliance Reports*

5.6.1.2. IFC Model Impact

This section summarizes the model requirements from all the process tasks analyzed above into two groups Extensions to R1.5.1 model object types and proposed new object types for R2.0.

Extensions to existing R1.5.1 Object Types

- ***IfcLayeredElement (Interfaces added to core class)***

  Data
  - *ContinuousRvalue - Ifcreal*
    - *Continuous R-value of assembly including air films, cladding, gypsum board and sheathing layers*
  - *AssemblyUfactor - Ifcreal*
    - *Overall assembly U-factor*

- ***IfcMaterialLayerSet (Interfaces added to resource schema)***

  Data
  - *ContinuousRvalue - Ifcreal*
    - *Continuous R-value of assembly including air films, cladding, gypsum board and sheathing layers*
  - *AssemblyUfactor - Ifcreal*
    - *Overall assembly U-factor*
  - *ParallelLayer1Material - Ref[IfcMaterialLayer]*
    - *Reference to first part of parallel portion of layered assembly*
  - *ParallelLayer2Materiall - Ref[IfcMaterialLayer]*
    - *Reference to second part of parallel portion of layered assembly*
  - *AspectRatioOfLayers - Ifcreal*
    - *Ratio of layer 1 to layer 2*

- ***IfcMaterialLayer (Interfaces added to resource schema)***

  Data
  - *MaterialType - Ref[IfcMaterialTypeLibraryEntry]*
    - *Type reference for homogenous material -- only used if not a material set*
  - *MaterialSet - Ref[IfcMaterialLayerSet]*
    - *Set of materials for material -- only used if not a homogenous material*

- ***IfcWall (Attribute added to core class)***

  Data
  - *AboveGrade - IfcReal*
    - *Ratio of wall area that is above grade to total wall area*

- ***IfcRoof (This class to replace IfcRoofSlab because there are several other roof types)***

  Data
  - *GenericType - IfcRoofTypeEnum*

  - *Predefined generic types are specified in an Enum. A Type definition is available for each generic type (as the required attributes differ). Use TypeDefinition corresponding to this generic type.*
- *RoofType - Ref[IfcfTypeDefinition]*
  - *Reference to a type definition that links to attributes defining the element (either shared by all instances or added to the ExAttributeSets). Specific TypeDef determined by the Generic Type above.*

- ***IfcFillingElement***

  Data
  - *FillingElementType - [Ref [IfcFillingElementTypeLibraryEntry]*
    - *Predefined generic filling element types specified in a library*
  - *ProjectionFactor - IfcReal*
    - *The ratio of shading projection depth to the height of window*

New object types required in IFC R2.0

- ***IfcPropertyConstraint (To establish a specific limit on an object or attribute of an object)***

  Data
  - *Source - IfcOwnerId*
    - *Code/Standard reference*
  - *ReferenceObject - IfcProjectObject/ IfcAttributeObject*
    - *Object / attribute reference for which the constraint is specified*
  - *Relation - IfcNumericRelation*
  - *ConstraintType - IfcConstraintLevel*
  - *NoticeText - IfcString*

- ***IfcIntent (A collection of attributes representing design intent)***

  Data
  - *Source - IfcOwnerId*
    - *Code/Standard reference ??*
  - *Description - IfcString*
    - *Description of the code requirement*

- ***IfcAggregateControl (A collection of attributes representing the logical relationships between design intent and constraint)***

  Data
  - *Source - IfcOwnerId*
    - *Code/Standard reference*
  - *Operation - IfcLogicalOperation*
    - *Logical relationship between intent and constraint*

- ***IfcBuildingEnvelope***

  Data
  - *AggregateOf - Set[0:N] Ref[IfcLayeredElement]*
    - *Contains references to all instances of layered elements which form the envelope*
  - *OccupancyType - IfcEnvelopeOccupancyTypeEnum*
    - *Envelope occupancy type according to the Standard*
  - *InternalLoadDensity - IfcReal*
    - *Total internal load based on the occupancy*
  - *ThermalLoad - IfcReal*
    - *Envelope load based on the proposed design*

- ***IfcSkylight***

  Data
  - *GenericType - IfcSkylightTypeEnum*

    - *Predefined generic types are specified in an Enum. A Type definition is available for each generic type (as the required attributes differ). Use TypeDefinition corresponding to this generic type.*
- *SkylightType - Ref[IfcTypeDefinition]*
    - *Reference to a type definition which links to attributes defining the element (either shared by all instances or added to the ExAttributeSets). Specific TypeDef determined by the GenericType above.*

- ***IfcLightingElement (An aggregation class containing all the lighting fixtures)***

  Data
  - *ReferenceObjects - Ref[IfcFixture]*
    - *Contains references to all instances of IfcFixture that are part of the lighting system*
  - *OccupancyType - IfcLightingOccupancyType*
    - *Lighting occupancy type according to the Standard*
  - *LightingPowerDensity - IfcReal*
    - *Lighting power density specified by the Code (based on Occupancy type)*
  - *LighingPower - IfcReal*
    - *Total lighting power for the proposed design*

- ***IfcLightingFixture***

  Data
  - *Category - Ref[IfcLightingFixtureType LibraryEntry]*
    - *The category of lighting fixture*
  - *NumberOfLampsPerFixture - IfcReal*
    - *Number of lamps per fixture*
  - *FixtureIdentification - IfcString*
    - *Fixture identification on plan*
  - *FixtureWattage - IfcInteger*
    - *Total input wattage of the fixture including lamps and ballast*
  - *NumberOfFixtures - IfcInteger*
    - *Total number of this fixture type used in the building*

- ***IfcMaterial Type (Class structure for material properties library--Not addition to Core class)***

  Data
  - *Type - IfcMaterialTypeEnum*
    - *Describes the function of the material layer as an Enum*
  - *ThermalResistance - IfcReal*
    - *Thermal resistance of the material for unit thickness*
  - *HeatCapacity - IfcReal*
    - *Specific heat capacity of the wall material*

- ***IfcFillingElementType (Class structure for filling element library--Not addition to Core class)***

  Data
  - *FramingType - IfcFrameTypeEnum*
    - *Enum representing the frame type*
  - *GlazingType - IfcGlazingTypeEnum*
    - *Enum representing the glazing type*
  - *ThermalResistance - IfcReal*
    - *Thermal resistance of the filling material*
  - *ShadingCoefficient - IfcReal*
    - *Shading coefficient of filling material*

- ***IfcLightingFixtureType (Class structure for lighting fixture library--Not addition to Core class)***

  Data
  - *Description - IfcString*

  - *Description of the lighting Fixture*
- *LampType - IfcLampTypeEnum*
  - *Lamp type*
- *LampDescription - IfcString*
  - *Description of the lamp type*
- *WattagePerLamp - IfcInteger*
  - *Power used by each lamp in the fixture*
- *BallastType - IfcBallastTypeEnum*
  - *The type of ballast used in the fixture*

5.6.1.3. RoadMap Issues

Interoperability Value

Disciplines/Applications from which information is needed:

- *Architecture*
- *HVAC*
- *Lighting*

Disciplines/Applications to which information will be supplied:

- *Architecture*
- *HVAC*
- *Lighting*

Value of software supporting this process

In this section, other domain teams will rank the value of software which supports this process, based on IFC. Value from 1-10, 1 being the lowest value, 10 being the highest value.

- *Not assessed for this project*

Sponsor Software Companies

The following software companies have shown interest in developing applications which implement the process

- *Pacific Northwest National Laboratory*
- *Autodesk (was Softdesk)*

5.6.1.4. Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues

Proposed resolution

- {{ Issue 1 }}
  - {{ Proposed resolution }}
- {{ Issue 2 }}
  - {{ Proposed resolution }}

5.7. [CS-2]

5.8. [ES-1]

5.9. [FM-3]

5.10. [FM-4]

5.11. [SI-1]

5.12. [XM-2]

6. Object Type Definition Tables

6.1. [AR-1] Architectural Model Extensions

6.1.1. Object Types

6.1.1.1. Building Shell Design

		Object Type Name	Interface name		OPT INV DER					
Subtype of				Attribute / Relation name		Data Type/Related Object Type	Min	Max	Default	Definition
IfcBuildingElement (an assembly, defined using IfcRelAssemblesElements)	1	**IfcCurtainWall**								Exterior wall of a building which is an assembly of components, hung from the edge of the floor/roof structure rather than bearing on a floor
			I_CurtainWall : ConstructionDetails, SpecSection							
				ConstructionDetails		LIST [0:?] OF IfcDocumentReference	n/a	n/a	empty list	List of references to a detail drawings
				SpecSection	OPT	IfcDocumentReference	n/a	n/a	NIL	Document reference to specification section
IfcBuildingElement	2	**IfcCurtainWallElement**								Component in an building curtain wall
			I_CurtainWallElement : GenericType							
				GenericType		IfcCurtainWallElementTypeEnum	GlazingPanel	OverhangShade	GlazingPanel	Generic type which keys to type definition for all primary types of elements in Curtain walls. Anything missed will be represented using IfcProxy.
IfcBuildingElement	3	**IfcPermeableOpeningCover**								Permeable cover for an opening which allows airflow (definition BS 6100)
			I_PermeableOpeningCover : GenericType							
				GenericType		IfcPermeableOpeningCoverTypeEnum	Grate	Screen	Screen	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).
IfcFloor	4	**IfcRamp**								Inclined floor surface
			I_Ramp : Length, Width, Slope, Landings, Railings, ConstructionDetails, SpecSection							
				Length		IfcPositiveLengthMeasure	0.0	see type	0.0	length of ramp
				Width		IfcPositiveLengthMeasure	0.0	see type	0.0	width of ramp
				Slope		IfcAngleMeasure	0.0	see type	0.0	slope of ramp - relative to horizontal (non-sloping) floor
				Landings		LIST [0:2] OF Ref [IfcStairRampLanding]	n/a	n/a	empty list	References to landing objects that are either end of ramp.
				Railings		LIST [0:?] OF Ref [IfcRailing]	n/a	n/a	empty list	List of reference railings (either handrails or guardrails) for this ramp
				ConstructionDetails		LIST [0:?] OF Ref [IfcDocumentReference]	n/a	n/a	empty list	List of references to drawing documents which define construction details (especially dealing with drainage)
				SpecSection		Ref [IfcDocumentReference]	n/a	n/a	NIL	Reference to a section in the construction specifications

6.1.1.2. Building Core Design

*** None defined for this process ***

6.1.1.3. Stair Design

		Object Type Name	Interface name	OPT INV DER					
Subtype of			Attribute / Relation name		Data Type/Related Object Type	Min	Max	Default	Definition
IfcBuildingElement (Assembly using IfcRelAssemblesElements)	9	**IfcStair**							Assembly of building components allowing occupants to walk (step) from Floor (or Landing) to another at a different elevation.
			I_Stair : GenericType, EnclosingSpace, Protection						
			I_StairComponents(Landings, Flights						
			GenericType		IfcStairTypeEnum	FireStair	Standard AccessStair	Standard AccessStair	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).
			EnclosingSpace	OPT	Ref [IfcSpace]	n/a	n/a	NIL	Reference to the Space object in which this stair is enclosed (if any)
			Protection		BOOLEAN	FALSE	TRUE	FALSE	selection of protected or not protected stair set
			Landings		LIST [0:?] OF Ref [IfcStairRampLanding]	n/a	n/a	empty list	list relationships - landings included in this stair assembly
			Flights		LIST [1:?] OF Ref [IfcStairFlight]	n/a	n/a	empty list	list relationships - flights included in this stair assembly
IfcBuildingElement (Assembly using IfcRelAssemblesElements)	10	**IfcStairFlight**							Assembly of building components in a single "run" of stair steps (not interrupted by a landing). Also includes stringers, handrails, guardrails, etc.
			I_StairFlight : HeadRoom, Steps, Stringers, Railings, Landings						
			HeadRoom		IfcPositiveLengthMeasure	0.0	see type	0.0	Headroom clearence
			Steps		LIST [1:?] OF IfcStairStep	n/a	n/a	one step minimum	List of references to Stair Steps objects
			Stringers		LIST [0:?] OF IfcBeam	n/a	n/a	empty list	List of references to stringers for this flight. Note: stringers are a type of Beam
			Railings		LIST [0:?] OF IfcRailing	n/a	n/a	empty list	List of references to handrails and guardrails
			Landings		LIST [0:2] OF Ref [IfcStairRampLanding]	n/a	n/a	empty list	list relationships - landings included in this stair assembly
IfcBuildingElement	11	**IfcStairStep**							Individual step (riser + tread) within a stair flight. Allows human occupants to ascend or descend from one floor to another (at different elevations).
			I_StairStep : RiserHeight, TreadDepth, TreadMaterial, NosingMaterial, ConstructionDetail						
			RiserHeight		IfcPositiveLengthMeasure	0.0	30 cm	0.0	Distance from tread to tread
			TreadDepth		IfcPositiveLengthMeasure	0.0	30 cm	0.0	Distance from the front of the tread to back of the tread
			TreadMaterial		INTEGER	1	see type	1	Composition of tread. Index into the IfcMaterialList defined at the IfcBuildingElement supertype
			NosingMaterial		INTEGER	1	see type	1	Composition of tread. Index into the IfcMaterialList defined at the IfcBuildingElement supertype
			ConstructionDetail		Ref [IfcDocumentReference]	n/a	n/a	NIL	Reference to construction detail drawing
IfcFloor	12	**IfcStairOrRampLanding**							Floor section to which one or more stair flights connects. May or may not be adjacent to a building storey floor.
			I_StairOrRampLanding : PartOfStair, ConnectedFlights, HeadRoom, ConstructionDetails, Railings						

				PartOfStair	INV	Ref [IfcStair]	n/a	n/a	NIL	reference to the stair for which this landing is a component (inverse for Landings)
				ConnectedFlights	INV	LIST [0:?] OF Ref [IfcStairFlight]	n/a	n/a	empty list	list of Stair Flights connected to this landing
				HeadRoom		IfcPositiveLengthMeasure	0.0	see type	0.0	Headroom clearence
				ConstructionDetail		LIST [0:?] OF Ref [IfcDocumentReference]	n/a	n/a	NIL	Reference to construction detail drawing
				Railings		LIST [0:?] OF IfcRailing	n/a	n/a	empty list	List of references to handrails and guardrails for this landing
Subtype from IfcBuiltIn	13	**IfcRailing**								
			I_Railing : GenericType, RailingHardware							
				GenericType		IfcRailingTypeEnum	Handrail	Balustrade	Handrail	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).
				RailingHardware		LIST [0:?] OF IfcBuiltInAccessory	n/a	n/a	empty list	List of references to accessory/mounting hardware for this railing.
Subtype from IfcBuiltIn	14	**IfcCabinet**								
			I_Cabinet : GenericType, CabinetHardware							
				GenericType		IfcCabinetTypeEnum	Bathroom	Office	Bathroom	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).
				CabinetHardware		LIST [0:?] OF IfcBuiltInAccessory	n/a	n/a	empty list	List of references to accessory hardware for this cabinet.
Subtype from IfcBuiltIn	15	**IfcCounterOrShelf**								
			I_CounterOrShelf : GenericType, CounterOrShelfHardware							
				GenericType		IfcCouterOrShelfTypeEnum	Bathroom Counter	Shelf	Shelf	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).
				CounterOrShelfHardware		LIST [0:?] OF IfcBuiltInAccessory	n/a	n/a	empty list	List of references to accessory hardware for this counter or shelf.

6.1.1.4. Public Toilet Design

		Object Type Name	**Interface name**		OPT INV DER					
Subtype of				Attribute / Relation name		Data Type/Related Object Type	Min	Max	Default	Definition
IfcBuildingElement	16	**IfcPlumbingFixture**								
			I_PlumbingFixture : GenericType							
				GenericType		IfcPlumbingFixtureType	Faucet	Dishwasher	Faucet	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).
IfcBuildingElement	17	**IfcElectricalFixture**								

			I_ElectricalFixture : GenericType							
				GenericType		IfcElectricalFixtureTypeEnum	Light	RadiantHeater	Light	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).
IfcBuiltIn	**18**	**IfcBuiltInAccessory**								Building hardware or attached occupant accessory - attached to one or more building elements
			I_BuiltInAccessory : GenericType, MountingHeight, MountingType, ConstructionDetails, SpecSection							
				GenericType		IfcBuiltInAccessoryTypeEnum	DoorsAndWindows	CounterOrShelfHW	Bathroom	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).
				MountingHeight		IfcPositiveLengthMeasure	0.0	see type	0.0	height at which the item gets connect to the wall. Value of 0.0 means this property not set.
				MountingType		STRING	n/a	n/a	empty string	Description of the method for mounting
				ConstructionDetails		LIST [0:?] OF ObjectReference (IfcDocumentReference)	n/a	n/a	empty list	List of reference to construction detail drawings
				SpecSection		ObjectReference (IfcDocumentReference)	n/a	n/a	NIL	Reference to a section of the construction specification

6.1.1.5. Roof Design

		Object Type Name	Interface name		OPT INV DER					
Subtype of				Attribute / Relation name		Data Type/Related Object Type	Min	Max	Default	Definition
IfcBuildingElement (assembly using IfcRelAssembles)	5	**IfcRoof**								A description of the total roof
			I_Roof : GenericType, FireRating, AtticSpace							
			I_RoofComponents : RoofSlabs, RoofFrames							
			I_RoofSurface : calc_TotalRoofSurfaceArea							
			I_RoofDrainage : PrimaryDrainage, SecondaryDrainage							
Interface			**I_Snow : SnowZone, DesignSnowLoad**							
				GenericType		IfcRoofTypeEnum	Flat	OtherSloped	Flat	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).
				FireRating		IfcTimeDurationMeasure	see type	see type	60 min	Time duration for fire resistence the roof assembly is rated
				AtticSpace		Ref [IfcSpace]	n/a	n/a	NIL	Reference to a Space object - the untreated attic space under this roof. Used for thermal performance calculations.
				RoofSlabs		LIST [0:?] OF Ref [IfcRoofSlab]	n/a	n/a	empty list	list of references to roof surface objects (IfcRoofslab)
				RoofFrames		LIST [0:?] OF Ref [IfcRoofFrame]	n/a	n/a	empty list	list of references to roof frame objects (IfcRoofFrame)

		calc_TotalRoofSurfaceArea		IfcAreaMeasure	see type	see type	0	Total surface area of the roof. Note: this is a calculated value, based on all of the roofslabs included in this roof. A value of 0.0 means the value has not been calculated.
		PrimaryDrainage		LIST [0:?] OF Ref [IfcDistributionElement]	n/a	n/a	empty list	List of references to all Primary drains
		SecondaryDrainage		LIST [0:?] OF Ref [IfcDistributionElement]	n/a	n/a	empty list	List of references to all secondary drains (or scuppers)
		SnowZone		STRING	na	na	empty string	Zone indicating average number of inches accumulated
		DesignSnowLoad		IfcMassMeasure	0.0	see type	0.0	Weight of design snow load. Value of 0.0 means property not set.
		IfcRoofSlab						
		I_RoofSlab : GenericType, LayerInformation, RoofingMaterial, FireRating						
		GenericType		IfcRoofSlabTypeEnum	SolidRoofSlab	ElementedRoofSlab	LayeredRoofSlab	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).
		LayerInformation		IfcMaterialLayerSetUsage				References a MaterialLayerSet, defines the offset relative to the extrusion path and defines the ordering of layers (left to right or right to left).
		RoofingMaterial		INTEGER	1	N	1	Index into the list of material Layers - to the roofing material
		FireRating		IfcTimeDurationMeasure	see type	see type	60 min	Time duration for fire resistence the roof assembly is rated
		IfcMaterial						
		I_Material : MaterialName, MaterialClassification, RegisteredBy						
		I_SurfaceProperties : SurfaceReflectivity, SurfaceColor, SurfaceTexture						
		I_ThermalProperties : ThermalCoefficient						
		MaterialName		STRING				
		MaterialClassification		IfcClassificationList				
		RegisteredBy	INV	IfcProjectMaterialRegistry				
		SurfaceReflectivity		IfcPositiveRatioMeasure	0.00	1.00	0.00	Measure for the ration of light reflected (versus absorbed) by this surface. Value of 0.00 means the value has not been set.
		SurfaceColor		STRING	n/a	n/a	empty string	Color of this surface, using the xxx color standard
		SurfaceTexture		STRING	n/a	n/a	empty string	Surface bumpiness - using the xxx standard
		ThermalCoefficient		REAL	0.00	see type	0.00	Thermal "U-value" per unit thickness. Value of 0.00 means the value has not been set.
IfcBuildingElement (assembly using IfcRelAssembles)	6	**IfcRoofFrame**						A collection (assembly) of structural frame elements supporting a roof or segments of a roof
		I_RoofFrame : GenericType, SupportsRoofSlabs, DesignLoads, FireRating						
		GenericType		IfcRoofFrameTypeEnum	Framed	Pneumatic	Trussed	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).
		SupportsRoofSlabs		LIST [0:?] OF Ref [IfcRoofslab]	n/a	n/a	empty list	List of relationships - to the Roofslab objects supported by this RoofFrame
		DesignLoads		IfcOccurrencePropertySet (Pset_StructuralAreaLoads)	n/a	n/a	NIL	Reference to a Pset in the ExtensionPsets for this object -- the one defining the design loads for this roof frame. Pset_StructuralAreaLoads defines both the "Live" and "Dead" loads.
		FireRating		IfcTimeDurationMeasure	see type	see type	0.00	Time measure for which this assembly is rated in case of fire. Value of 0.00 means this attribute not set.

IfcRelationship	7	**IfcRelJoinsElements**								Expansion joint, edge condition, control joint.
			I_RelJoinsElements : RelatingObject, RelatedObjects, JointType, RangeOfMovement, ConstructionDetails, SpecSection, WaterProofing, FireRating, VentilationRequired, ManufactureInfo, ObjectLifeCycle							
				RelatingObject		Ref [IfcBuildingElement]	n/a	n/a	NIL	Primary object at the joint defined by this relationship
				RelatedObjects		LIST [1:?] OF Ref [IfcBuildingElement]	n/a	n/a	empty list	Secondard objects joined at the joint defined by this relationship
				JointElements		LIST [0:?] OF Ref [IfcBuildingElement]	n/a	n/a	empty list	Objects that make up the joint (fill the gap)
				JoinType		IfcJointTypeEnum	control	expansion	control	Purpose of joint
				RangeOfMovement		IfcPositiveLengthMeasure	0.00	n	0.00	Distance the joint can open before failing
				ConstructionDetails		LIST [0:?] OF Ref [IfcDocumentReference]	na	na	na	List of references to drawing documents which define construction details
				SpecSection		IfcDocumentReference	na	na	NIL	Reference to a section of the specification
				WaterProofing		BOOLEAN	FALSE	TRUE	FALSE	flag that indicates that the joint should be waterproof or not
				FireRating		IfcTimeDurationMeasure	see type	see type	60 min	Time duration for fire resistence the roof assembly is rated
				VentilationRequired		BOOLEAN	FALSE	TRUE	FALSE	Is ventilation required for this joint?
				ManuafactureInfo		IfcOccurrencePropertySet (Pset_ManufactureInfo)	n/a	n/a	NIL	Reference to information about the manufacturer of this joint assemlby (if any). ID of Pset_ManufactureInfo attached to object in the Extension Psets list
				ObjectLifeCycle		IfcOccurrencePropertySet (Pset_ObjectLifeCycle)	na	na	na	Reference to ObjectLifeCycle Pset - attached to object in the Extension Pset list
IfcBuildingElement	8	**IfcScreen**								
			I_Screen : GenericType							
				GenericType		IfcScreenTypeEnum	ScreenAssembly	ScreenDoorOrGate	ScreenPanel	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).

6.1.1.6. Componentization of Doors/Windows

		Object Type Name	**Interface name**		OPT INV DER					
Subtype of				Attribute / Relation name		Data Type/Related Object Type	Min	Max	Default	Definition
IfcBuildingElement	19	**IfcDoorPanel**								
			I_DoorPanel : GenericType, PanelHeight, PanelWidth, PanelThickness							
				GenericType		IfcDoorPanelTypeEnum	SwingDoor	RollupDoor	SwingDoor	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).
				PanelHeight		IfcPositiveLengthMeasure	0	see type	1800	Overall Height of this panel. Note this can be derived from the 'Shape' and included for convenience use by applications that cannot derive this from the shape.

			PanelWidth	IfcPositiveLengthMeasure	0	see type	900	Overall Width of this panel. Note this can be derived from the 'Shape' and included for convenience use by applications that cannot derive this from the shape.
			PanelThickness	IfcPositiveLengthMeasure	0	see type	50	Overall Thickness of this panel. Note this can be derived from the 'Shape' and included for convenience use by applications that cannot derive this from the shape.
IfcBuildingElement	20	**IfcWindowPanel**						
		I_WindowPanel : GenericType, PanelHeight, PanelWidth, PanelDepth, PanelFrameThickness, StileThickness, StileDepth						
			GenericType	IfcWindowPanelTypeEnum	FixedPanel	SwingPanel	FixedPanel	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).
			PanelHeight	IfcPositiveLengthMeasure	0	see type	1800	Overall Height of this panel. Note this can be derived from the 'Shape' and included for convenience use by applications that cannot derive this from the shape.
			PanelWidth	IfcPositiveLengthMeasure	0	see type	900	Overall Width of this panel. Note this can be derived from the 'Shape' and included for convenience use by applications that cannot derive this from the shape.
			PanelDepth	IfcPositiveLengthMeasure	0	see type	50	Overall Depth of this panel. Note this can be derived from the 'Shape' and included for convenience use by applications that cannot derive this from the shape.
			PanelFrameThickness	IfcPositiveLengthMeasure	0	see type	25	Thickness (width in plane parallel to glazing) of the panel frame. Note the PanelFrameDepth is taken to be = Depth for the panel
			StileThickness	IfcPositiveLengthMeasure	0	see type	25	Thickness (width in plane parallel to glazing) of the stiles dividing any glass panes
			StileDepth	IfcPositiveLengthMeasure	0	see type	25	Depth (dimension in plane perpendicular to glazing) of the stiles dividing any glass panes
IfcBuildingElement	21	**IfcDoorOrWindowFrame**						
		I_DoorORWindowFrame : GenericType, calc_FrameDepth, calc_FrameThickness						
			GenericType	IfcDoorOrWindowFrameTypeEnum	FramedInPlace	PreHung	FramedInPlace	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).
			calc_FrameDepth	IfcPositiveLengthMeasure	0	see type	150	Depth of the frame horizontal section, from front face (facing space 'A') to back face (facing space 'B')
			calc_FrameThickness	IfcPositiveLengthMeasure	0	see type	50	Thickness of the frame horizontal section, measured from inside of frame (at door panel) to outside of frame (at the rought opening in the host wall)
	22	**IfcGlazing**						
		I_Glazing : GenericType						
			GenericType	IfcGlazingTypeEnum	FramedInPlace	PreHung	FramedInPlace	Predefined generic types are specified in an Enum. Type driven Psets are defined for each generic type (as the required attributes differ). The GenericType for a given instance drives determines the type of Pset attached at runtime throug the associated TypeDef object (defined at the IfcObject supertype).

6.1.2. Type Definitions

#	TypeDef Name	Class being Typed	Description or definition / Generic Type	Specific Type	Set #	Shared Pset	Set #	Occurrence Pset
1	**BeamType**		Supports the definition of standard Beam types and associated PropertySets					
		IfcBeam		Common Pset			#N/A	Pset_BeamCommon
			StairStringer					
				< Any value >			4	Pset_BeamStairStringer
2	**BuiltInAccessoryType**		Supports the definition of standard Accessory types and associated PropertySets					
		IfcBuiltInAccessory		Common Pset			1	Pset_AccessoryCommon
			Bathroom					
				< Any value >			2	Pset_AccessoryBathroom
			DoorOrWindowHardware		3	Pset_AccessoryDoorOrWindowHardware		
3	**CabinetType**		Supports the definition of standard Cabinet types and associated PropertySets					
		IfcCabinet		Common Pset			5	Pset_CabinetCommon
			Bathroom					
				< Any value >	6	Pset_CabinetBathroom		
			Kitchen					
				< Any value >	7	Pset_CabinetKitchen		
			Storage					
				< Any value >	8	Pset_CabinetStorage		
			Laundry					
				< Any value >	9	Pset_CabinetLaundry		
			Office					
				< Any value >	10	Pset_CabinetOffice		
4	**CounterType**		Supports the definition of standard Counter types and associated PropertySets					
		IfcCounterOrShelf		Common Pset			11	Pset_CounterOrShelfCommon
			Counter					
				< Any value >			12	Pset_Counter
			Shelf					
				< Any value >			47	Pset_Shelf
5	**CoveringType**		Supports the definition of standard Covering types and associated PropertySets					
		IfcCovering		Common Pset			#N/A	Pset_CoveringCommon
			CoveringMillwork					
				< Any value >			13	Pset_CoveringMillwork

6	**CurtainWallElementType**	Supports the definition of standard CurtainWallElement types and associated PropertySets				
	IfcCurtainWallElement	Common Pset			14	Pset_CurtainWallElementCommon
		Clad Panels				
		< Any value >	15	Pset_CurtainWallCladPanel		
		Glazing Panel				
		< Any value >	16	Pset_CurtainWallGlazingPanel		
		Ornamental Projection				
		< Any value >	17	Pset_CurtainWallProjectionOrnamental		
		Shade or Overhang				
			18	Pset_CurtainWallShadeOverhang		
		Spandrel Panel				
			19	Pset_CurtainWallSpandrelPanel		
7	**DistributionElementType**	Supports the definition of standard DistributionElement types and associated PropertySets				
	IfcDistributionElement	Common Pset			#N/A	Pset_DistributionElementCommon
		Roof Drainage				
		Drain			21	Pset_DistributionDrain
		Gutter			22	Pset_DistributionGutter
		Scupper			20	Pset_DistributionScupper
8	**DocumentReferenceType**	Supports the definition of standard DocumentReference types and associated PropertySets				
	IfcDocumentReference	Common Pset			#N/A	Pset_DocumenReferenceCommon
		Specifications				
		< Any value >			23	Pset_DocumentSpecSection
9	**EquipmentType**	Supports the definition of standard Equipment types and associated PropertySets				
	IfcEquipment	Common Pset			#N/A	Pset_EquipmentCommon
		Elevator				
		< Any value >			25	Pset_EquipmentElevator
		Escalator				
		< Any value >			26	Pset_EquipmentEscalator
		Window Cleaning				
		< Any value >			27	Pset_EquipmentWindowCleaningElement
10	**PathwayType**	Supports the definition of standard Pathway types and associated PropertySets				
	IfcPathway	Common Pset			#N/A	Pset_PathwayCommon
		RoofAccessPath				

				< Any value >	30	Pset_PathwayRoofAccessPath
11	**PermeableOpeningCoverType**		Supports the definition of standard PermeableOpeningCover types and associated PropertySets			
		IfcPermeableOpeningCover		Common Pset	34	Pset_PermOpenCoverCommon
			Grill			
				< Any value >	31	Pset_PermOpenCoverGrill
			Louver			
				< Any value >	32	Pset_PermOpenCoverLouver
			Screen			
				< Any value >	33	Pset_PermOpenCoverScreen
12	**PlumbingFixtureType**		Supports the definition of standard PlumbingFixture types and associated PropertySets			
		IfcPlumbingFixture		Common Pset	35	Pset_PlumbingFixtureCommon
			Faucet			
				< Any value >	#N/A	Pset_PlumbingFixtureFaucet
			Sink			
				< Any value >	#N/A	Pset_PlumbingFixtureSink
			Shower			
				< Any value >	#N/A	Pset_PlumbingFixtureShower
			Toilet			
				< Any value >	#N/A	Pset_PlumbingFixtureToilet
			Urinal			
				< Any value >	#N/A	Pset_PlumbingFixtureUrinal
13	**VisualScreenType**		Supports the definition of standard Screen types and associated PropertySets			
		IfcVisualScreen		Common Pset	42	Pset_VisualScreenCommon
			Assembly			
				< Any value >	43	Pset_VisualScreenAssembly
			DoorOrGate			
				Restroom Partition Door	41	Pset_VisualScreenRestroomPartitionDoor
				< Any other value >	46	Pset_VisualScreenDoorOrGate
			Panel			
				Restroom Partition	40	Pset_VisualScreenRestroomPartition
				< Any other value >	45	Pset_VisualScreenPanel
			Post			
				< Any value >	44	Pset_VisualScreenPost
10	**RailingType**		Supports the definition of standard Railing types and associated PropertySets			
		IfcRailing		Common Pset	36	Pset_RailingCommon
			Handrail			
				< Any value >	37	Pset_RailingHandrail

No.	Type / Object	Predefined type	Value	Definition	Ref	Pset
		Guardrail				
			< Any value >		38	Pset_RailingGuardrail
		Balustrade				
			< Any value >		39	Pset_RailingBalustrade
11	**SpaceType**	Supports the definition of standard Space types and associated PropertySets				
	IfcSpace		Common Pset		#N/A	Pset_SpaceCommon
		CirculationSpace				
			StairShaft		49	Pset_SpaceStairShaft
			< Any other value >		#N/A	Pset_SpaceCirculation
		TechnicalSpace				
			Elevator Shaft		48	Pset_SpaceElevatorShaft
			< Any other value >		#N/A	Pset_SpaceTechnical
12	**WallType**	Supports the definition of standard Wall types and associated PropertySets				
	IfcWall		Common Pset		#N/A	Pset_WallCommon
		Partition				
			< Any value >		#N/A	Pset_WallPartition
13	**WindowType**	Supports the definition of standard Window types and associated PropertySets				
	IfcWindow		Common Pset		#N/A	Pset_WindowCommon
		Skylight				
			< Any value >		51	Pset_WindowSkylight
14	**Extension Psets**	PropertySets which extend the definition of many types of objects				
	Any Object					
		Maintenance			24	Pset_ElementMaintenance
		Maintenance Record			28	Pset_MaintenanceRecord
		Object Life Cycle			29	Pset_ObjectLifeCycle

6.1.3. Property Sets

	PropertySet (Pset) Name / Attribute / Relation name	Definition	Data Type or Related Object	Min	Max	Default
1	**Pset_AccessoryCommon**					
	ManuafactureInfo	reference to Manufacturer information	ObjectReference (Pset_ManufactureInfo)	n/a	n/a	NIL
	ManufacturerMaterial	Material selection - from the manufacturer's material options for this fixture type	IfcString	n/a	n/a	empty string
	ManufacturerColor	Color selection - from the manufacturer's color options for this fixture type	IfcString	n/a	n/a	empty string
	ManufacturerFinish	Finish selection - from the manufacturer's finish options for this fixture type	IfcString	n/a	n/a	empty string
	Target objects for this PropertySet					
	IfcBuiltInAccessory					

2	**Pset_AccessoryBathroom**	These are what are commonly referred to as "Bathroom Accessories"				
	CommonAccessoryProperties	Reference to the SharedPropertySet (Pset_AccessoryCommon). Contains the shared values for this type -- of properties that are stored for all Screen elements.	IfcObjectReference (Pset_AccessoryCommon)	n/a	n/a	NIL
	Property2	Not yet defined				
	Target objects for this PropertySet					
	IfcBuiltInAccessory					
3	**Pset_AccessoryDoorOrWindow Hardware**					
	CommonAccessoryProperties	Reference to the SharedPropertySet (Pset_AccessoryCommon). Contains the shared values for this type -- of properties that are stored for all Screen elements.	IfcObjectReference (Pset_AccessoryCommon)	n/a	n/a	NIL
	ProjectHwGroupReference	Project reference ID for this standard collection of hardware elements for doors	IfcString	see type	see type	empty string
	TypeDescription	Description for this type of frame (note name is captured in the TypeDef object that references this PropertySet)	IfcString	see type	see type	empty string
	DoorHardwareElementIndexList	A list of indicies into the enumeration referenced by DoorHardwareElementEnum. Note: this list will be implemented as a shared Pset_DoorHardwareGroupElements - a list of IfcInteger indicies into that enum.	LIST [1:?] OF IfcInteger	1	10	1
	DoorHardwareElementEnum	Reference to a Pset enumerating all possible door hardware elements for this hardware group. Note: this will be implemented as a shared PropertySet (Pset_DoorHardwareElementEnum) of IfcString (values enumerated at right).	IfcObjectReference (Pset_DoorHardwareEleme ntEnum - ENUMERATION OF (Hingeset, Lockset, Handset, Deadbolt, Kickplate, Pushplate, Peephole, Knocker, DoorStop, Passthrough))	n/a	n/a	NIL
	Target objects for this PropertySet					
	IfcBuiltInAccessory					
4	**Pset_BeamStairStringer**					
	Slope	Slope for this stringer - relative to horizontal (0.0 degrees).	IfcAngleMeasure	0.0	see type	0.0
	ConstructionDetails	List of references to construction detail drawings	LIST [0:?] OF ObjectReference (IfcDocumentReference)	n/a	n/a	empty list
	Target objects for this PropertySet					
	IfcBeam					
5	**Pset_CabinetCommon**					
	ManuafactureInfo	reference to Manufacturer information	ObjectReference (Pset_ManufactureInfo)	n/a	n/a	NIL
	ConstructionDetail	Reference to construction detail drawing	Ref [IfcDocumentReference]	n/a	n/a	NIL
	SpecSection	Reference to a section of the construction specification	ObjectReference (IfcDocumentReference)	n/a	n/a	NIL
	Target objects for this PropertySet					
	IfcCabinet					
6	**Pset_CabinetBathroom**					
	CommonCabinetProperties	Reference to the SharedPropertySet (Pset_CabinetCommon). Contains the shared values for this type -- of properties that are stored for all types of cabinets.	IfcObjectReference (Pset_CabinetCommon)	n/a	n/a	NIL
	Property2	Not yet defined				
	Target objects for this PropertySet					

				IfcCabinet					
7		**Pset_CabinetKitchen**							
				CommonCabinetProperties	Reference to the SharedPropertySet (Pset_CabinetCommon). Contains the shared values for this type -- of properties that are stored for all types of cabinets.	IfcObjectReference (Pset_CabinetCommon)	n/a	n/a	NIL
				Property2	Not yet defined				
			Target objects for this PropertySet						
				IfcCabinet					
8		**Pset_CabinetStorage**							
				CommonCabinetProperties	Reference to the SharedPropertySet (Pset_CabinetCommon). Contains the shared values for this type -- of properties that are stored for all types of cabinets.	IfcObjectReference (Pset_CabinetCommon)	n/a	n/a	NIL
				Property2	Not yet defined				
			Target objects for this PropertySet						
				IfcCabinet					
9		**Pset_CabinetLaundry**							
				CommonCabinetProperties	Reference to the SharedPropertySet (Pset_CabinetCommon). Contains the shared values for this type -- of properties that are stored for all types of cabinets.	IfcObjectReference (Pset_CabinetCommon)	n/a	n/a	NIL
				Property2	Not yet defined				
			Target objects for this PropertySet						
				IfcCabinet					
10		**Pset_CabinetOffice**							
				CommonCabinetProperties	Reference to the SharedPropertySet (Pset_CabinetCommon). Contains the shared values for this type -- of properties that are stored for all types of cabinets.	IfcObjectReference (Pset_CabinetCommon)	n/a	n/a	NIL
				Property2	Not yet defined				
			Target objects for this PropertySet						
				IfcCabinet					
11		**Pset_CounterOrShelfCommon**							
				ManuafactureInfo	reference to Manufacturer information	ObjectReference (Pset_ManufactureInfo)	n/a	n/a	NIL
				ConstructionDetail	Reference to construction detail drawing	Ref [IfcDocumentReference]	n/a	n/a	NIL
				SpecSection	Reference to a section of the construction specification	ObjectReference (IfcDocumentReference)	n/a	n/a	NIL
			Target objects for this PropertySet						
				IfcCounterOrShelf					
12		**Pset_Counter**							
				CommonCounterOrShelfProperties	Reference to the SharedPropertySet (Pset_CounterOrShelfCommon). Contains the shared values for this type -- of properties that are stored for all types of counters and shelves.	IfcObjectReference (Pset_CounterOrShelfCommon)	n/a	n/a	NIL
				Property2	Not yet defined				
			Target objects for this PropertySet						
				IfcCounterOrShelf					
13		**Pset_CoveringMillwork**							

	CommonCoveringProperties	Reference to a SharedPropertySet (Pset_CoveringCommon). Contains the shared values for this type -- of properties that are stored for all Covering elements.	IfcObjectReference (Pset_CoveringCommon)	n/a	n/a	NIL
	ConstructionDetail	Reference to a construction detail drawing file	ObjectReference (IfcDocumentReference)	n/a	n/a	NIL
	Target objects for this PropertySet					
	IfcCovering					
14	**Pset_CurtainWallElementCommon**	Defines properties common for all CurtainWall elements.				
	ManufactureInformation	Reference to a SharedPropertySet - Pset_ManufactureInformation, which defines information about the manufacture of this element.	IfcObjectReference (Pset_ManufactureInformation)	n/a	n/a	NIL
	LifecycleInformation	Reference to lifecycle	IfcObjectReference (Pset_ObjectLifecycle)	na	na	NIL
	ConstructionDetails	List of references to a detail drawings	LIST [0:?] OF IfcDocumentReference	n/a	n/a	empty list
	SpecSection	Document reference to specification section	IfcDocumentReference	n/a	n/a	NIL
	BldgCodeRefs	List of document references to building codes	LIST [0:?] OF IfcDocumentReference	n/a	n/a	empty list
	Target objects for this PropertySet					
	IfcCurtainWallElement					
15	**Pset_CurtainWallCladPanel**					
	CommonCurtainWallElementProperties	Reference to the 'parent' SharedPropertySet (Pset_CurtainWallElementType). Contains the shared values for this type -- of properties that are stored for all CurtainWallElements.	IfcObjectReference (Pset_CurtainWallElementType)	n/a	n/a	NIL
	Target objects for this PropertySet					
	IfcCurtainWallElement					
16	**Pset_CurtainWallGlazingPanel**					
	CommonCurtainWallElementProperties	Reference to the 'parent' SharedPropertySet (Pset_CurtainWallElementType). Contains the shared values for this type -- of properties that are stored for all CurtainWallElements.	IfcObjectReference (Pset_CurtainWallElementType)	n/a	n/a	NIL
	Target objects for this PropertySet					
	IfcCurtainWallElement					
17	**Pset_CurtainWallProjectionOrnamental**					
	CommonCurtainWallElementProperties	Reference to the 'parent' SharedPropertySet (Pset_CurtainWallElementType). Contains the shared values for this type -- of properties that are stored for all CurtainWallElements.	IfcObjectReference (Pset_CurtainWallElementType)	n/a	n/a	NIL
	Description	Description of this projecting element	IfcString	n/a	n/a	empty string
	Weight	Total weight of projection	IfcMassMeasure	0.0	see type	0.0
	ConstructionDetails	Reference to detail construction drawings for connection to façade (ie. bolt, screw or fastener detail)	LIST [0:?] OF ObjectReference (IfcDocumentReference)	n/a	n/a	NIL
	Services	References to building services needed (e.g. electrical to an operable canopy)	LIST [0:?] OF ObjectReference (IfcSystem)	n/a	n/a	empty list
	Target objects for this PropertySet					
	IfcCurtainWallElement					
18	**Pset_CurtainWallShadeOverhang**					

	CommonCurtainWallElementProperties	Reference to the 'parent' SharedPropertySet (Pset_CurtainWallElementType). Contains the shared values for this type -- of properties that are stored for all CurtainWallElements.	IfcObjectReference (Pset_CurtainWallElement Type)	n/a	n/a	NIL
	Target objects for this PropertySet					
	IfcCurtainWallElement					
19	**Pset_CurtainWallSpandrelPanel**					
	CommonCurtainWallElementProperties	Reference to the 'parent' SharedPropertySet (Pset_CurtainWallElementType). Contains the shared values for this type -- of properties that are stored for all CurtainWallElements.	IfcObjectReference (Pset_CurtainWallElement Type)	n/a	n/a	NIL
	Target objects for this PropertySet					
	IfcCurtainWallElement					
20	**Pset_DistributionScupper**	General opening/edge condition designed to distribute (convey) overflow drainage from a roof or deck.				
	ManuafactureInfo	reference to Manufacturer information	ObjectReference (Pset_ManufactureInfo)	n/a	n/a	NIL
	ConstructionDetail	Reference to a construction detail drawing	ObjectReference [IfcDocumentReference]	na	na	na
	SpecSection	Reference to a section of the specification	ObjectReference (IfcDocumentReference)	na	na	NIL
	Target objects for this PropertySet					
	IfcDistributionElement	Roof or Downspout				
21	**Pset_DistributionDrain**					
	ManuafactureInfo	reference to Manufacturer information	ObjectReference (Pset_ManufactureInfo)	n/a	n/a	NIL
	TributaryAreaDrained	Area for this this is the primary drain. Value of 0.00 means this value has not been set.	IfcAreaMeasure	see type	see type	0.00
	FlowCapacity	Calculated capacity of drain flow. Value of 0.00 means this value has not been set.	IfcFlowMeasure	see type	see type	0.00
	ConstructionDetail	Reference to a construction detail drawing	ObjectReference (IfcDocumentReference)	na	na	NIL
	SpecSection	Reference to a section of the specification	ObjectReference (IfcDocumentReference)	na	na	NIL
	Target objects for this PropertySet					
	IfcDistributionElement					
22	**Pset_DistributionGutter**					
	Slope	angle of the gutter to allow for drainage	IfcAngleMeasure	0.0	see type	0.0
	FlowCapacity	Calculated capacity of drain flow. Value of 0.00 means this value has not been set.	IfcFlowMeasure	see type	see type	0.00
	ConstructionDetail	Reference to a construction detail drawing	ObjectReference (IfcDocumentReference)	na	na	NIL
	SpecSection	Reference to a section of the specification	ObjectReference (IfcDocumentReference)	na	na	NIL
	Target objects for this PropertySet					
	IfcDistributionElement					
23	**Pset_DocumentSpecSection**					
	CommonDocumentReferenceProperties	Reference to a SharedPropertySet (Pset_DocumentReferenceCommon), which contains the properties that are stored for all types of Document References.	IfcObjectReference (Pset_DocumentReference Common)	n/a	n/a	NIL
	SectionID	Section number or ID for the referenced section	IfcString	n/a	n/a	empty string
	OffsetToSection	Byte count offset from beginning of file to the beginning of the referenced section. Value of 0 means offset not set.	IfcInteger	0	see type	0

	Target objects for this PropertySet						
	IfcDocumentReference						
24	**Pset_ElementMaintenance**						
	ElementMaintenanceConditionEnum	Reference to nested enumeration property set Pset_ElementMaintenanceConditionEnum. This enumeration defines the general conditions for a building element requiring routine maintenance.	ENUMERATION OF (GoodCondition, RequiresMonitoring, RequiresRoutineMaintenance, RequiresRepair, RequiresReplacement, Other, NotKnown, Unset)	n/a	n/a	NIL
	ElementMaintenanceConditionIndex	Index into the nested enumeration property set Pset_ElementMaintenanceConditionEnum	IfcInteger	1	N	1
	ServiceActor	The person or maintenance service provider responsible for the maintenance of the element	IfcActorSelect	n/a	n/a	NIL
	MaintenanceRecords	List of references to maintenance records for this element.	LIST [0:?] OF IfcSharedPropertySet (Pset_MaintenanceRecord)	n/a	n/a	empty list
	Target objects for this PropertySet					
	IfcElement					
25	**Pset_EquipmentElevator**					
	CommonEquipmentProperties	Reference to a SharedPropertySet (Pset_EquipmentCommon) which defines properties that are stored for all types of equipment.	IfcSharedPropertySet (Pset_EquipmentCommon)	n/a	n/a	NIL
	Occupancy	Number of occupants	IfcInteger	0	see type	0
	ManufactureInfo	Nested Pset defining manufacturing info	IfcSharedPropertySet (Pset_ManufacturInfo)	n/a	n/a	NIL
	LoadCapacity	Weight capacity of elevator	IfcMassMeasure	see type	see type	0
	ClientBrief	Reference to program to gain requirements for occupancy	ObjectReference (IfcClientBrief)	n/a	n/a	NIL
	Target objects for this PropertySet					
	IfcEquipment					
26	**Pset_EquipmentEscalator**					
	CommonEquipmentProperties	Reference to a SharedPropertySet (Pset_EquipmentCommon) which defines properties that are stored for all types of equipment.	IfcSharedPropertySet (Pset_EquipmentCommon)	n/a	n/a	NIL
	Capacity	number of people that can be moved from the top to the bottom	IfcInteger	0	see type	0
	ManufactureInfo	reference to Pset_ManufactureInfo	ObjectReference (Pset_ManufacturInfo)	n/a	n/a	NIL
	ClientBrief	Link to program to gain requirements for occupancy	ObjectReference (IfcClientBrief)	n/a	n/a	NIL
	Target objects for this PropertySet					
	IfcEquipment					
27	**Pset_EquipmentWindowCleaningElement**					
	CommonEquipmentProperties	Reference to a SharedPropertySet (Pset_EquipmentCommon) which defines properties that are stored for all types of equipment.	IfcSharedPropertySet (Pset_EquipmentCommon)	n/a	n/a	NIL
	WindowCleaningElementTypeEnum	Enumeration of the various	Enum (Apparatus, Carriage, Rails, Rigging, Tracks)	Apparatus	Tracks	Carriage
	WindowCleaningElementTypeIndex	Index (in the enum above) indicating the type of window cleaning system element for this object	IfcInteger	1	5	2
	Target objects for this PropertySet					
	IfcEquipment					
28	**Pset_MaintenanceRecord**					
	MaintenanceDate	Date maintenance performed	IfcDateTimeSelect	see type	see type	1-Jan-72

	MaintenanceReason	Description of Problem	IfcString	see type	see type	empty string
	MaintenanceDescription	Description of what work was performed	IfcString	see type	see type	empty string
	Crew	Maintenance crew involved	LIST [0:?] OF IfcActorSelect	n/a	n/a	empty list
	Target objects for this PropertySet					
	IfcRoof, Pset_LifeCycle					
29	**Pset_ObjectLifeCycle**					
	InstallationDate	Date of installation	IfcDateTimeSelect	see type	see type	1-Jan-72
	ServiceLife	Time period inwhich the object is projected to last without replacement	IfcTimeDurationMeasure	see type	see type	0
	Warranty	Legal description of time period that the manufacturer is responsible for replacement	IfcTimeDurationMeasure	see type	see type	0
	MaintenanceInterval	Time period between each maintenance cycle	IfcTimeDurationMeasure	see type	see type	0
	MaintenanceRequirements	Requirments for maintenance	IfcString	see type	see type	empty string
	MaintenanceHistory	List of links to maintenance records	LIST [0:?] IfcObjectReference (Pset_MaintenanceRecord)	n/a	n/a	empty list
	LifeCycleCost	Total cost of object (may be an assembly) over the LifeCycleCostPeriod	IfcCost	0.0	see type	0.0
	LifeCycleCostPeriod	Life for which the LifeCycleCost has been calculated	IfcTimeDurationMeasure	see type	see type	0.0
	SalvageValue	Value if recycled or returned when replacement	IfcCost	0.0	n	0.0
	Target objects for this PropertySet					
	IfcAssemblyCurtainWall, IfcRoofSlab					
30	**Pset_PathwayRoofAccessPath**					
	PathLength	Description of walk to mechanical	IfcPositiveLengthMeasure	0.0	see type	0.0
	PathWidth	Distance across path	IfcPositiveLengthMeasure	0.0	see type	0.0
	Target objects for this PropertySet					
	IfcPathway					
31	**Pset_PermOpenCoverGrill**					
	CommonPermeableOpeningCoverProperties	Reference to the 'parent' SharedPropertySet (Pset_PermeableOpeningCoverType). Contains the shared values for this type -- of properties that are stored for all PermeableOpeningCovers.	IfcObjectReference (Pset_PermeableOpeningCoverType)	n/a	n/a	NIL
	GrillMaterial	Primary material from which this grill is made - an index into the MaterialSet associated with this building element	IfcInteger	0	see type	0
	HorzSpacing	Spacing of the screening wire at the angle set by Orientation. "0.0" indicates value not set.	IfcPositiveLengthMeasure	see type	see type	0.0
	VertSpacing	Spacing of the screening wire at the angle perpendicular to that set by Orientation. "0.0" indicates value not set.	IfcPositiveLengthMeasure	see type	see type	0.0
	FinWidth	Width (when viewed from finished side) of the fins in this grill. Value of 0.0 means value not set.	IfcPositiveLengthMeasure	see type	see type	0.0
	FinDepth	depth (finished side to back side) of the fins in this grill. Value of 0.0 means value not set.	IfcPositiveLengthMeasure	see type	see type	0.0
	Target objects for this PropertySet					
	IfcPermeableOpeningCover					
32	**Pset_PermOpenCoverLouver**	A type of permeable cover for an opening (which allows airflow). Louvers may be placed in any Opening.				
	CommonPermeableOpeningCoverProperties	Reference to the 'parent' SharedPropertySet (Pset_PermeableOpeningCoverType). Contains the shared values for this type -- of properties that are stored for all PermeableOpeningCovers.	IfcObjectReference (Pset_PermeableOpeningCoverType)	n/a	n/a	NIL

	LouverMaterial	Primary material from which this louver is made - an index into the MaterialSet associated with this building element	IfcInteger	0	see type	0
	FinSpacing	Distance between adjacent fins. "0.0" indicates value not set.	IfcPositiveLengthMeasure	see type	see type	0.0
	FinAngle	Slope angle of the fins, in cross-sectional view with finished (or exterior) face on the right side of the section. Horzontal fin angle is taken to be zero ("0") angle.	IfcAngleMeasure	0.0	<360.0	0.0
	FinDepth	Fin depth measure, in cross-sectional view. "0.0" indicates value not set.	IfcPositiveLengthMeasure	see type	see type	0.0
	InsideScreen	Reference to a screen on the inside of these louvers	ObjectReference (Pset_PermOpenCoverScreen)	n/a	n/a	NIL
	Target objects for this PropertySet					
	IfcPermeableOpeningCover					
33	**Pset_PermOpenCoverScreen**					
	CommonPermeableOpeningCoverProperties	Reference to the 'parent' SharedPropertySet (Pset_PermeableOpeningCoverType). Contains the shared values for this type -- of properties that are stored for all PermeableOpeningCovers.	IfcObjectReference (Pset_PermeableOpeningCoverType)	n/a	n/a	NIL
	ScreenMaterial	Primary material from which this screen is made - an index into the MaterialSet associated with this building element	IfcInteger	0	see type	0
	HorzSpacing	Spacing of the screening wire at the angle set by Orientation. "0.0" indicates value not set.	IfcPositiveLengthMeasure	see type	see type	0.0
	VertSpacing	Spacing of the screening wire at the angle perpendicular to that set by Orientation. "0.0" indicates value not set.	IfcPositiveLengthMeasure	see type	see type	0.0
	ScreenThickness	Thickness of the screening wire	IfcPositiveLengthMeasure	see type	see type	0.5
	Target objects for this PropertySet					
	IfcPermeableOpeningCover					
34	**Pset_PermOpenCoverCommon**	Permeable cover for an opening which allows airflow (definition BS 6100)				
	TypeDescription	Description for this type of louver (note name is captured in the TypeDef object that references this PropertySet)	IfcString	see type	see type	empty string
	ManufactureInformation	Reference to a SharedPropertySet - Pset_ManufactureInformation, which defines information about the manufacture of this door hardware.	IfcObjectReference (Pset_ManufactureInformation)	n/a	n/a	NIL
	RequiredOpeningHeight	Overall Height of the required opening for this louver. Note this can be derived from the 'ProductShape' and is included for convenience use by applications that cannot derive this from the shape. Zero means this property has not been set.	IfcPositiveLengthMeasure	0	see type	0
	RequiredOpeningWidth	Overall Width of the required opening for this louver. Note this can be derived from the 'ProductShape' and is included for convenience use by applications that cannot derive this from the shape. Zero means this property has not been set.	IfcPositiveLengthMeasure	0	see type	0
	FrameWidth	Average length measure, when viewed from the finished face, from the edge of the louver to fins.	IfcPositiveLengthMeasure	see type	see type	1.0
	FrameDepth	Measure of the frame depth (front to back)	IfcPositiveLengthMeasure	see type	see type	1.0
	Orientation	Orientation angle, when facing the finished side of installed louvers. Horzontal is taken to be zero ("0") angle. Angle is positive in counter-clockwise rotation.	IfcAngleMeasure	0.0	<360.0	0.0
	ConstructionDetail	Reference to a construction detail drawing	IfcObjectReference (IfcDocumentReference)	see type	see type	NIL
	SpecSection	Reference to a section in the construction specifications	IfcObjectReference (IfcDocumentReference)	see type	see type	NIL
	FreeAreaVentilation	Actual usable Area. Zero means this value has not been set.	IfcAreaMeasure	0	see type	0
	ClearanceSpace	Distance needed for correct operation/air flow	ObjectReference (IfcSpace)	see type	see type	NIL

	Operable	Designation of operability of this cover	IfcBoolean	FALSE	TRUE	FALSE
	Control	Reference to control system if needed	ObjectReference (IfcSystem)	see type	see type	NIL
	Target objects for this PropertySet					
	IfcPermeableOpeningCover					
35	**Pset_PlumbingFixtureCommon**					
	ManuafactureInfo	reference to Manufacturer information	ObjectReference (Pset_ManufactureInfo)	n/a	n/a	NIL
	FunctionalHeight	Height from floor to functional opening. Value of 0.0 means this property not set.	IfcPositiveLengthMeasure	0.0	see type	0.0
	MountingHeight	height at which the item gets connect to the wall. Value of 0.0 means this property not set.	IfcPositiveLengthMeasure	0.0	see type	0.0
	MountingType	Description of the method for mounting	IfcString	n/a	n/a	empty string
	DrainConnectPoint	Reference to the connection object relating this plumbing fixture to the sewer piping system (the drain)	ObjectReference (IfcRelConnectsElements)	n/a	n/a	NIL
	HwconnectPoint	Reference to the connection object relating this plumbing fixture to the hot water plumbing system.	ObjectReference (IfcRelConnectsElements)	n/a	n/a	NIL
	CWconnectPoint	Reference to the connection object relating this plumbing fixture to the cold water plumbing system	ObjectReference (IfcRelConnectsElements)	n/a	n/a	NIL
	ElectricalConnectPoint	Reference to the connection object relating this plumbing fixture to the electrical power system	ObjectReference (IfcRelConnectsElements)	n/a	n/a	NIL
	ConstructionDetails	List of reference to construction detail drawings	LIST [0:?] OF ObjectReference (IfcDocumentReference)	n/a	n/a	empty list
	SpecSection	Reference to a section of the construction specification	ObjectReference (IfcDocumentReference)	n/a	n/a	NIL
	OperationalSpace	Space around fixture required for proper use by occupants	ObjectReference (IfcSpace)	0	N	0
	ManufacturerMaterial	Material selection - from the manufacturer's material options for this fixture type	IfcString	n/a	n/a	empty string
	ManufacturerColor	Color selection - from the manufacturer's color options for this fixture type	IfcString	n/a	n/a	empty string
	ManufacturerFinish	Finish selection - from the manufacturer's finish options for this fixture type	IfcString	n/a	n/a	empty string
	Target objects for this PropertySet					
	IfcPlumbingFixture					
36	**Pset_RailingCommon**					
	ManuafactureInfo	reference to Manufacturer information	ObjectReference (Pset_ManufactureInfo)	n/a	n/a	NIL
	ConstructionDetail	Reference to construction detail drawing	Ref [IfcDocumentReference]	n/a	n/a	NIL
	SpecSection	Reference to a section of the construction specification	ObjectReference (IfcDocumentReference)	n/a	n/a	NIL
	Target objects for this PropertySet					
	IfcRailing					
37	**Pset_RailingHandrail**					
	CommonRailingProperties	Reference to the SharedPropertySet (Pset_RailingCommon). Contains the shared values for this type -- of properties that are stored for all Railing elements.	IfcObjectReference (Pset_RailingCommon)	n/a	n/a	NIL
	HandrailMaterial	Index into the IfcMaterialList defined in the IfcElement supertype	IfcInteger	1	MaterialList length	1
	HandrailHeight	Height to top of handrail - from stair, landing or floor	IfcPositiveLengthMeasure	0.0	see type	0.0
	MaxDistanceFromWall	Distance from the wall to the outside of the handrail. Value of 0.0 means value not set.	IfcPositiveLengthMeasure	0.0	see type	0.0
	Target objects for this PropertySet					
	IfcRailing					
38	**Pset_RailingGuardrail**					

	CommonRailingProperties	Reference to the SharedPropertySet (Pset_RailingCommon). Contains the shared values for this type -- of properties that are stored for all Railing elements.	IfcObjectReference (Pset_RailingCommon)	n/a	n/a	NIL
	Height	Height to the top of the guardrail - from stair, landing or floor	IfcPositiveLengthMeasure	0.0	see type	0.0
	RepeatingElements	reference to definition of repeating rail stiles - defined in a Pset in the ExtensionPsets for this object	Ref [Pset_RepeatingElement]	n/a	n/a	NIL
	MountedHandrail	Reference to any handrail mounted on this guardrail	Ref [IfcRailing]	n/a	n/a	NIL
	Target objects for this PropertySet					
	IfcRailing					
39	**Pset_RailingBalustrade**					
	CommonRailingProperties	Reference to the SharedPropertySet (Pset_RailingCommon). Contains the shared values for this type -- of properties that are stored for all Railing elements.	IfcObjectReference (Pset_RailingCommon)	n/a	n/a	NIL
	BalustradeProperty2	Property not defined yet				
	Target objects for this PropertySet					
	IfcRailing					
40	**Pset_VisualScreenRestroomPartition**					
	CommonVisualScreenElementProperties	Reference to the 'parent' SharedPropertySet (Pset_VisualScreenCommon). Contains the shared values for this type -- of properties that are stored for all VisualScreen elements.	IfcObjectReference (Pset_VisualScreenCommon)	n/a	n/a	NIL
	ManufacturerMaterial	Material selection - from the manufacturer's material options for this fixture type	IfcString	n/a	n/a	empty string
	ManufacturerColor	Color selection - from the manufacturer's color options for this fixture type	IfcString	n/a	n/a	empty string
	ManufacturerFinish	Finish selection - from the manufacturer's finish options for this fixture type	IfcString	n/a	n/a	empty string
	Target objects for this PropertySet					
	IfcVisualScreen					
41	**Pset_VisualScreenRestroomPartitionDoor**					
	CommonVisualScreenElementProperties	Reference to the 'parent' SharedPropertySet (Pset_VisualScreenCommon). Contains the shared values for this type -- of properties that are stored for all VisualScreen elements.	IfcObjectReference (Pset_VisualScreenCommon)	n/a	n/a	NIL
	HingeSide	Indicates the hinged side of the door - when viewed from outside the partition enclosure. 0=left, 1=right.	IfcLogical	0	1	1
	SwingDirection	Indicates whether this door swings into or out of the partition enclosure. 0=swings in, 1=swings out.	IfcLogical	0	1	1
	ManufacturerMaterial	Material selection - from the manufacturer's material options for this fixture type	IfcString	n/a	n/a	empty string
	ManufacturerColor	Color selection - from the manufacturer's color options for this fixture type	IfcString	n/a	n/a	empty string
	ManufacturerFinish	Finish selection - from the manufacturer's finish options for this fixture type	IfcString	n/a	n/a	empty string
	Target objects for this PropertySet					
	IfcVisualScreen					
42	**Pset_VisualScreenCommon**					
	VisualScreenElementHeight	Height of the partition panel. Value of 0.0 means property not set.	IfcPositiveLengthMeasure	0.0	see type	0.0
	VisualScreenElementWidth	Width of the partition panel. Value of 0.0 means property not set.	IfcPositiveLengthMeasure	0.0	see type	0.0
	VisualScreenElementThickness	Thickness of the partition panel. Value of 0.0 means property not set.	IfcPositiveLengthMeasure	0.0	see type	0.0
	AssembledTopOfElementHeight	Height, from finish floor, to the top of this partition panel. Value of 0.0 means property not set.	IfcPositiveLengthMeasure	0.0	see type	0.0

				AssemblyHardware	List of references to mounting/assembly hardware components for this panel only	LIST [0:?] OF ObjectReference (IfcBuiltInAccessories)	n/a	n/a	empty list
			Target objects for this PropertySet						
				IfcVisualScreen					
43		**Pset_VisualScreenAssembly**							
				ManuafactureInfo	reference to Manufacturer information	ObjectReference (Pset_ManufactureInfo)	n/a	n/a	NIL
				ConstructionDetails	List of reference to construction detail drawings	LIST [0:?] OF ObjectReference (IfcDocumentReference)	n/a	n/a	empty list
				SpecSection	Reference to a section of the construction specification	ObjectReference (IfcDocumentReference)	n/a	n/a	NIL
			Target objects for this PropertySet						
				IfcVisualScreen					
44		**Pset_VisualScreenPost**							
				CommonVisualScreenProperties	Reference to the SharedPropertySet (Pset_VisualScreenCommon) - which contains properties that are stored for all types of VisualScreen elements.	IfcSharedPropertySet (Pset_VisualScreenCommo n)	n/a	n/a	NIL
				PostProperty2	This property has not yet been defined				
			Target objects for this PropertySet						
				IfcVisualScreen					
45		**Pset_VisualScreenPanel**							
				CommonVisualScreenProperties	Reference to the SharedPropertySet (Pset_VisualScreenCommon) - which contains properties that are stored for all types of VisualScreen elements.	IfcSharedPropertySet (Pset_VisualScreenCommo n)	n/a	n/a	NIL
				VisualScreenProperty2	This property has not yet been defined				
			Target objects for this PropertySet						
				IfcVisualScreen					
46		**Pset_VisualScreenDoorOrGate**							
				CommonVisualScreenProperties	Reference to the SharedPropertySet (Pset_VisualScreenCommon) - which contains properties that are stored for all types of VisualScreen elements.	IfcSharedPropertySet (Pset_VisualScreenCommo n)	n/a	n/a	NIL
				DoorProperty2	This property has not yet been defined				
			Target objects for this PropertySet						
				IfcVisualScreen					
47		**Pset_Shelf**							
				CommonCounterOrShelfProperties	Reference to the SharedPropertySet (Pset_CounterOrShelfCommon). Contains the shared values for this type -- of properties that are stored for all types of counters and shelves.	IfcObjectReference (Pset_CounterOrShelfCom mon)	n/a	n/a	NIL
				Property2	Not yet defined				
			Target objects for this PropertySet						
				IfcCounterOrShelf					
48		**Pset_SpaceElevatorShaft**			Specific type of Technical Space (generic type defined in R1.5)				
				CommonSpaceProperties	Reference to the 'parent' PropertySet (Pset_SpaceCommon). Contains the shared values for this type -- of properties that are stored for all Spaces.	IfcObjectReference (Pset_SpaceCommon)	n/a	n/a	NIL
				BldgStoriesServiced	List of references to all the IfcBuildinStorey objects that are serviced by this elevator shaft	LIST [0:?] OF Ref [IfcBuildingStorey]	n/a	n/a	empty list

#	Name	Description	Type			
	Target objects for this PropertySet					
	IfcSpace					
49	**Pset_SpaceStairShaft**					
	CommonSpaceProperties	Reference to the 'parent' PropertySet (Pset_SpaceCommon). Contains the shared values for this type -- of properties that are stored for all Spaces.	IfcObjectReference (Pset_SpaceCommon)	n/a	n/a	NIL
	BldgStoriesServiced	List of references to all the IfcBuildinStorey objects that are serviced by this elevator shaft	LIST [0:?] OF Ref [IfcBuildingStorey]	n/a	n/a	empty list
	Target objects for this PropertySet					
	IfcSpace					
50	**Pset_WallParapet**					
	CommonWallProperties	Reference to the 'parent' PropertySet (Pset_WallType). Contains the shared values for this type -- of properties that are stored for all walls.	IfcObjectReference (Pset_WallType)	n/a	n/a	NIL
	RepeatingElements	Reference to a Pset (Pset_RepeatingElement) describing any repeating elements for this wall (NIL pointer if not)	IfcObjectReference (Pset_RepeatingElement)	n/a	n/a	NIL
	CapMaterial	Index into the Material list defined at the IfcElement level - points to material from which cap is made.	IfcInteger	see type	see type	1
	CapManuafacturerInfo	Reference to a SharedPropertySet - Pset_ManufactureInformation, which defines information about the manufacture of the parapet cap.	IfcObjectReference (Pset_ManufactureInformation)	n/a	n/a	NIL
	ConstructionDetails	Document references to detail drawings	LIST [0:?] OF IfcDocumentReference	n/a	n/a	empty list
	ParapetFunctionTypeEnum	Reference to a Pset enumerating possible parapet functional roles. Note: this will be implemented as a shared PropertySet (Pset_ParapetFunctionTypeEnum) of IfcString (values enumerated at right).	IfcObjectReference (Pset_ParapetFunctionTypeEnum - ENUMERATION OF (window washing rigging support, handrail, screen, fire block))	n/a	n/a	NIL
	ParapetFunctionTypeIndex	List of Integer indicies into the enumeration defined by Pset_ParapetFunctionTypeEnum.	LIST [1:?] OF IfcInteger	1	4	empty list
	SpecSection	Reference to relevant section of the construction specifications	ObjectReferenc (IfcDocumentReference)	n/a	n/a	empty list
	Target objects for this PropertySet					
	IfcWall					
51	**Pset_WindowSkylight**					
	CommonWindowProperties	Reference to the 'parent' PropertySet (Pset_WindowType). Contains the shared values for this type -- of properties that are stored for all windows.	IfcSharedPropertySet (Pset_WindowType)	n/a	n/a	NIL
	WindowPanelList	Reference to one or more window panels (defined left to right or bottom to top), as viewed from the finished (exterior) face (see diagram in specificaitons). NOTES: 1) this will be implemented as a shared Pset_WindowPanelList - which contains a list of s	LIST [1:?] OF IfcObjectReference (Pset_WindowPanel)	n/a	n/a	NIL
	Operable	Is this Skylight operable?	IfcBoolean	FALSE	TRUE	FALSE
	Target objects for this PropertySet					
	IfcWindow					

6.2. [AR-2] Compartmentation of Buildings

6.2.1. Object Types

The following table is pasted from the speadsheet template "R2_ObjectDefs_d4.xls", sheet "Class Definitions"

		Object Type Name	Interface name		OPT INV DER					
Subtype of				Attribute / Relation name		Data Type/Related Object Type	Min	Max	Default	Definition
IfcCharacteristic	1	**IfcSpaceOccupancy**								IfcSharedSpatialElements schema
			I_SpaceOccupancy							
				OccupancyNumber	OPT	IfcOccupancyNumber	see type	see type	see type	
				Owner	OPT	IfcOccupant	see type	see type	see type	
				Rental	OPT	IfcOccupant	see type	see type	see type	
				Lease	OPT	IfcOccupant	see type	see type	see type	
IfcCharacteristic	2	**IfcOccupant**								IfcSharedSpatialElements schema
			I_Occupant							
				GenericType		IfcOccupantTypeEnum	Owner	Lessee	Tenant	
				OccupantName	OPT	IfcActorSelect				
IfcCharacteristic	3	**IfcOccupancyNumber**								IfcSharedSpatialElements schema
			I_OccupancyNumber							
				GenericType		IfcOccupancyNumberTypeEnum	Number	Number	Number	
				ActualOccupancyNumber	OPT	INTEGER	0	see type	1	
				DesignIntentOccupancyNumber	OPT	INTEGER	0	see type	1	
				CumulativeOccupancyNumber	OPT	INTEGER	0	see type	1	
				OccupancyRate	OPT	IfcPersonPerAreaMeasure	0	see type	1	
IfcSpace	4	**IfcFireCompartment**								IfcSharedSpatialElements schema
			I_FireCompartment							
				calcHeightAboveGrade	OPT	IfcLengthMeasure	see type	see type	1.0	
				MainFireUse	OPT	IfcClassification	see type	see type	see type	Main fire use for the space which is assigned from the Fire Use Classification.
				AncillaryFireUse	OPT	IfcClassification	see type	see type	see type	Ancillary fire use for the space which is assigned from the Fire Use Classification.
				FireRiskFactor	OPT	INTEGER	see type	see type	see type	Fire Risk factor assigned to the space
				NaturalVentilation	OPT	BOOLEAN	see type	see type	see type	Indication whether the space is ventilated natural (true) or mechanical (false).
				SprinklerProtection	OPT	BOOLEAN	see type	see type	see type	Indication whether the space is sprinkler protected (true) or not (false).

6.2.2. Type Definitions

None were defined.

6.2.3. Property Sets

None were defined.

6.3. [BS-1] HVAC System Design

6.3.1. Object Types

The following table is pasted from the speadsheet template "R2_ObjectDefs_d4.xls", sheet "Class Definitions"

Class Name		{{ "Ref" = relationship }}				
Interface name		Data Type	Min	Max	Default	Units
IfcPathwayElement	This class connects together the parts of a networked system.					
InheritsFrom ---------->	IfcBuildingElement					
I_PathwayElement						
PathwayElementType	Named type of PathwayElement. References a PathwayElement TypeDef which links to attributes shared by all instances of this type.	Ref [IfcTypeDefinition]	n/a	n/a	NIL	n/a
InletPointConnections	Specifies which IfcPointConnectors are inlets. All remaining IfcPointConnectors are therefore outlets.	List [0:N] Ref [IfcPointConnector]	n/a	n/a	NIL	n/a
MaterialLayerSet	Material layer set the pathway element is constructed with. We use a material layer set to allow multiple materials to be used to construct a pathway element.	Ref [IfcMaterialLayerSet]	n/a	n/a	NIL	n/a
IsMountedOn	IfcObject that the device is mounted upon or attached to, such as a wall or structural support. This relationship allows the PathwayElement to appropriately move if the object it is mounted' upon is moved, while maintaining its system interconnectivity.	Ref[IfcObject]	n/a	n/a	NIL	n/a
Description	A user-defined string description of the pathway element	IfcString	see type	see type	empty string	n/a
IfcDamper	This class is used to control or reduce air flow in a duct system.					
InheritsFrom ---------->	IfcPathwayElement					
I_Damper						
DamperType	Named type of Damper References a Damper TypeDef which links to attributes shared by all instances of this type.	Ref [IfcTypeDefinition]	n/a	n/a	NIL	n/a
Inlet Connection	Inlet Connection references a Size AttDef which contains the shape and size of the connection (e.g., Att_RoundDuctConnection)	Ref [IfcAttDef]	n/a	n/a	NIL	n/a
Outlet Connection	Outlet Connection references a Size AttDef which contains the shape and size of the connection (e.g., Att_RoundDuctConnection)	Ref [IfcAttDef]	n/a	n/a	NIL	n/a
Frame Depth	The length (or depth) of the damper frame	IfcLengthMeasure	see type	see type	0.0	n/a
SizingMethod	Enumeration that identifies whether the damper is sized nominally or with exact measurements	Enum [Nominal, Exact]	n/a	n/a	Nominal	n/a
Manufacturer	The manufacturer of the damper assembly	IfcString	see type	see type	empty string	n/a
Model	The manufacturer's model number of the damper assembly	IfcString	see type	see type	empty string	n/a
WorkingPressure	The actual working pressure of the damper assembly	IfcPressureMeasure	see type	see type	0.0	n/a

Class	Interface	Attribute	Description	Type			Default	
		DesignPressureRating	The design pressure rating for the damper assembly	IfcPressureMeasure	see type	see type	0.0	n/a
		PressureLoss	The pressure loss across the damper assembly	IfcPressureMeasure	see type	see type	0.0	n/a
		CloseOffRating	Close off rating	IfcPressureMeasure	see type	see type	0.0	n/a
		LeakageAirFlowrate	Leakage air flow rate	IfcVolumetricFlowrate Measure	see type	see type	0.0	n/a
IfcControlElement			This class is used to identify control components that are typically a part of any HVAC duct or piping system.					
		InheritsFrom ---------->	IfcPathwayElement					
	I_ControlElement							
		ControlElementType	Named type of ControlElement references a ControlElement TypeDef which links to attributes shared by all instances of this type.	Ref [IfcTypeDefinition]	n/a	n/a	NIL	n/a
		BACnetObjectType	The BACnet object type of the device	IfcString	see type	see type	empty string	n/a
		PointID	The Point Identification assigned to this control element	IfcString	see type	see type	empty string	n/a
IfcActuator			This class is used to identify actuators.					
		InheritsFrom ---------->	IfcControlElement					
	I_Actuator							
		ActuatorType	Named type of Actuator; references an Actuator TypeDef which links to attributes shared by all instances of this type.	Ref [IfcTypeDefinition]	n/a	n/a	NIL	n/a
		ActuatorFunction	Named type of Actuator references an Actuator TypeDef which links to attributes which vary by type.	Ref [IfcTypeDefinition]	n/a	n/a	NIL	n/a
		Operation	Enumeration that identifies the type of motion the actuator provides	Enum [Modulating, TwoPosition]	n/a	n/a	Modulating	n/a
		FailPosition	Enumeration that identifies the behavior of the actuator in case of power failure	Enum [FailOpen, FailClosed, None]	n/a	n/a	FailOpen	n/a

6.3.2. Type Definitions

The following table is pasted from the speadsheet template "R2_ObjectDefs_d4.xls", sheet "Type Definitions"

	#						Description
	#	**TypeDef Name**					*Description*
			Class being Typed				
				Generic Type			
Defined					Specific Type / project defining type		
In							Property Sets
	PreDefined Type Definitions for IFC Release 2						
BS-1		**PathwayElementType**					Allows definition of defined types of pathway elements
			IfcPathwayElement				
				AirTerminal			
					< Any value >		
					BS-1	shared =	Pset_AirTerminal
						occurrence =	<none defined>
				Damper			
					< Any value >		
					BS-1	shared =	Pset_Damper
						occurrence =	<none defined>
				TerminalBox			
					< Any value >		
					BS-1	shared =	Pset_TerminalBox

								occurrence =	*<none defined>*
					DuctFitting				
						< Any value >			
						BS-1		*shared =*	*Pset_DuctFitting*
								occurrence =	*<none defined>*
					DuctSegment				
						< Any value >			
						BS-1		*shared =*	*Pset_DuctSegment*
								occurrence =	*<none defined>*
					Valve				
						< Any value >			
						BS-1		*shared =*	*Pset_Valve*
								occurrence =	*<none defined>*
					PipeFitting				
						< Any value >			
						BS-1		*shared =*	*Pset_PipeFitting*
								occurrence =	*<none defined>*
					PipeSegment				
						< Any value >			
						BS-1		*shared =*	*Pset_PipeSegment*
								occurrence =	*<none defined>*
BS-1			**Damper**						*Allows definition of defined types of dampers*
				IfcDamper					
					FireDamper				
						< Any value >			
						BS-1		*shared =*	*Pset_FireDamper*
								occurrence =	*<none defined>*
					SmokeDamper				
						< Any value >			
						BS-1		*shared =*	*Pset_SmokeDamper*
								occurrence =	*<none defined>*
					FireSmokeDamper				
						< Any value >			
						BS-1		*shared =*	*Pset_FireSmokeDamper*
								occurrence =	*<none defined>*
					BackdraftDamper				
						< Any value >			
						BS-1		*shared =*	*Pset_BackdraftDamper*
								occurrence =	*<none defined>*
					ControlDamper				
						< Any value >			
						BS-1		*shared =*	*Pset_ControlDamper*
						BS-1		*occurrence =*	*<none defined>*
					Louver				
						< Any value >			
						BS-1		*shared =*	*Pset_Louver*
						BS-1		*occurrence =*	*<none defined>*
BS-1			**ControlElement**						*Allows definition of defined types of control elements*
				IfcControlElement					

			Controller			
				< Any value >		
				BS-1	shared =	Pset_Controller
					occurrence =	<none defined>
			Sensor			
				< Any value >		
				BS-1	shared =	Pset_Sensor
					occurrence =	<none defined>
BS-1	**Actuator**					Allows definition of defined types of actuators
		IfcControlElement				
			LinearActuator			
				< Any value >		
				BS-1	shared =	Pset_LinearActuator
				BS-1	occurrence =	Pset_ElectricActuator, Pset_PneumaticActuator, Pset_HydraulicActuator, Pset_HandOperatedActuator
			RotationalActuator			
				< Any value >		
				BS-1	shared =	Pset_RotationalActuator
				BS-1	occurrence =	Pset_ElectricActuator, Pset_PneumaticActuator, Pset_HydraulicActuator, Pset_HandOperatedActuator

6.3.3. Property Sets

The following table is pasted from the speadsheet template "R3_ObjectDefs_d4.xls", sheet "PropertySet Definitions."

	Property Set Name								
			Property name	***Definition***	***Data Type***	***Min***	***Max***	***Default***	***Units***
PreDefined Property Sets for IFC Release 2									
			Note: These tables define property sets for 3 purposes						
			1. Shared property sets associated with a type (see TypeDefinition above)						
			2. Variable property sets associated with a type (those which vary for each occurrence)						
			3. Domain extension model extensions to classes in the IFC Core						
			This table is divided into 3 parts, according to the purpose of the property set						
Shared Property Sets defining Type									
	BS-1 Model								
PathwayElement				*PointConnections, combined with the information in a connection type property set (i.e., Pset_RectangularDuctConnection, Pset_RoundDuctConnection) attached to the referenced IfcPointConnector, provide the required information for the type, size and location of physical connections.*					
	Pset_AirTerminal								
		Purpose		*This property set will be used by an IfcPathwayElement object for defining Air Terminals*					
			AirTerminalType	Enumeration defining the type of Air Terminal	Enum [Supply, Return, Exhaust, Other]	n/a	n/a	Supply	n/a
			Flowrate	Maximum air flowrate for the terminal device	IfcVolumetricFlowrateMeasure	see type	see type	0.0	n/a
			PressureLoss	Pressure loss through the terminal device	IfcPressureMeasure	see type	see type	0.0	n/a
			Throw	The distance the air terminal throws the air (optional)	IfcLengthMeasure	see type	see type	0.0	n/a
			SoundLevel	Design sound power level	IfcString	see type	see type	empty string	n/a
			ADPI	Air diffusion performance index	REAL	0.0	0.0	0.0	n/a
			InletConnection	Reference to the size and shape of the inlet connection (e.g., Pset_RoundDuctConnection)	Ref [IfcAttDef]	see type	see type	NIL	n/a
			OutletConnection	Reference to the size and shape of the outlet connection (e.g., Pset_RoundDuctConnection)	Ref [IfcAttDef]	see type	see type	NIL	n/a

FinishType	Enumeration that identifies the type of finish for the air terminal	Enum [Anodized, Paint, None]	n/a	n/a	None	n/a
FinishColor	The finish color for the air terminal	IfcString	see type	see type	empty string	n/a
MountingFrame	Frame for plaster, drywall, lay-in grid, etc.	IfcString	see type	see type	empty string	n/a
AdjustableCore	Permits adjustment of throw	IfcString	see type	see type	empty string	n/a
CoreSetHorizontal	Degree of blade set from the centerline	IfcPlaneAngleMeasure	see type	see type	0.0	n/a
CoreSetVertical	Degree of blade set from the centerline	IfcPlaneAngleMeasure	see type	see type	0.0	n/a
IntegralDamper	Reference to a damper object that is integral to the terminal device	Ref [IfcDamper]	see type	see type	NIL	n/a
IntegralControl	Self powered temperature control	BOOL	FALSE	TRUE	FALSE	n/a
Pset_TerminalBox						
Purpose	This property set will be used by an IfcPathwayElement object to define Terminal Boxes					
TerminalBoxType	Enumeration that identifies the type of terminal box: VAV, CV, VVRH, etc.	Enum [VAV, CV, VAVReheat, CVReheat, FanPowered, VAVDualDuct, CVDualDuct]	n/a	n/a	VAV	n/a
DesignFlowrate	Maximum air flowrate for the terminal box	IfcVolumetricFlowrateMeasure	see type	see type	0.0	n/a
MinimumFlowrate	Minimum air flowrate for the terminal box	IfcVolumetricFlowrateMeasure	see type	see type	0.0	n/a
PressureLoss	Pressure loss through the terminal box	IfcPressureMeasure	see type	see type	0.0	n/a
SoundLevel	Design sound power level	IfcString	see type	see type	empty string	n/a
Pset_DuctFitting						
Purpose	This property set will be used by an IfcPathwayElement object to define duct fittings. This property set is used in conjunction with an Pset_DuctDesignCriteria which defines common duct design parameters.					
PrimaryType	Enumeration that identifies the primary type of fitting (i.e., elbow, transition, junction, etc.)	Enum [Entry, Exit, Elbow, Transition, Junction, Obstruction, Hood, Other]	n/a	n/a	Elbow	n/a
SubType	Subtype of fitting (i.e., 5-gore, pleated, stamped, etc.)	IfcString	see type	see type	empty string	n/a
EnteringPressure	Actual pressure required for balancing and maintenance	IfcPressureMeasure	see type	see type	0.0	n/a
Angle	Angle of turn for elbows, transitions, etc.	IfcPlaneAngleMeasure	see type	see type	0.0	n/a
Pset_DuctSegment						
Purpose	This property set will be used by an IfcPathwayElement object to define duct segments. This property set is used in conjunction with an Pset_DuctDesignCriteria which defines common duct design parameters					
Flowrate	Flowrate through the duct	IfcVolumetricFlowrateMeasure	see type	see type	0.0	n/a
EnteringPressure	Actual pressure required for balancing and maintenance	IfcPressureMeasure	see type	see type	0.0	n/a
SupportMethod	Reference to a duct hanger or other structural support from roof, floor, etc.	Ref [IfcObject]	see type	see type	NIL	n/a
FinishedLength	The finished length of the duct segment	IfcLengthMeasure	see type	see type	0.0	n/a
LongitudinalSeam	The type of seam to be used along the longitudinal axis of the duct segment	IfcString	see type	see type	empty string	n/a
Reinforcement	The type of reinforcement used for the duct segment	IfcString	see type	see type	empty string	n/a
ReinforcementSpacing	The spacing between reinforcing elements	IfcLengthMeasure	see type	see type	0.0	n/a
Pset_Valve						
Purpose	This property set will be used by an IfcPathwayElement object to define valves					
WorkingPressure	Working pressure	IfcPressureMeasure	see type	see type	0.0	n/a
PressureDrop	Pressure drop	IfcPressureMeasure	see type	see type	0.0	n/a
CloseOffRating	Close off rating	IfcPressureMeasure	see type	see type	0.0	n/a
ValveCv	Cv value for the valve	REAL	0.0	0.0	0.0	n/a
Pset_PipeFitting						
Purpose	This property set will be used by an IfcPathwayElement object to define pipe fittings. This property set is used in conjunction with an Pset_PipeDesignCriteria which defines common pipe design parameters					
PrimaryType	Enumeration that identifies the primary type of fitting (i.e., elbow, transition, junction, etc.)	Enum [Entry, Exit, Elbow, Transition, Junction, Obstruction, Other]	n/a	n/a	Elbow	n/a
SubType	Subtype of fitting (i.e., long-radius, short-radius,	IfcString	see type	see type	empty	n/a

	etc.)				string	
EnteringPressure	Actual pressure required for balancing and maintenance	IfcPressureMeasure	see type	see type	0.0	n/a
Angle	Angle of turn for elbows, transitions, etc.	IfcPlaneAngleMeasure	see type	see type	0.0	n/a
Pset_PipeSegment						
Purpose	This property set will be used by an IfcPathwayElement object to define pipe segments. This property set is used in conjunction with an Pset_PipeDesignCriteria which defines common pipe design parameters					
Flowrate	Flowrate through the pipe	IfcVolumetricFlowrateMeasure	see type	see type	0.0	n/a
EnteringPressure	Actual pressure required for balancing and maintenance	IfcPressureMeasure	see type	see type	0.0	n/a
SupportMethod	Reference to a pipe hanger or other structural support from roof, floor, etc.	Ref [IfcObject]	see type	see type	NIL	n/a
FinishedLength	The finished length of the pipe segment	IfcLengthMeasure	see type	see type	0.0	n/a
Pset_FireDamper						
Purpose	This property set will be used by an IfcDamper object to define the characteristics of a fire damper					
ClosureRating	Enumeration that identifies the closure rating for the damper	Enum [Dynamic, Static]	n/a	n/a	Dynamic	n/a
FireResistanceRating	Enumeration that identifies the fire resistance rating of the damper	Enum [1-1/2Hour, 3Hour]	n/a	n/a	1-1/2Hour	n/a
Mounting	Enumeration that identifies how the damper is mounted in the building	Enum [Horizontal, Vertical]	n/a	n/a	Vertical	n/a
FusibleLinkTemperature	The temperature that the fusible link melts	IfcThermodynamicTemperatureMeasure	see type	see type	0.0	n/a
SleeveLength	The length of the damper sleeve	IfcLengthMeasure	see type	see type	0.0	n/a
SleeveThickness	The thickness of the damper sleeve	IfcLengthMeasure	see type	see type	0.0	n/a
DamperLocationInSleeve	The location within the sleeve where the damper is mounted (e.g., Center)	IfcString	see type	see type	empty string	n/a
Pset_SmokeDamper						
Purpose	This property set will be used by an IfcDamper object to define the characteristics of a smoke damper					
FrameThickness	The thickness of the damper frame	IfcLengthMeasure	see type	see type	0.0	n/a
BladeType	The type of blade used in the damper (e.g., Triple Vee, Fabricated Airfoil, Extruded Airfoil, etc.)	IfcString	see type	see type	empty string	n/a
Mounting	Enumeration that identifies how the damper is mounted in the building	Enum [Horizontal, Vertical]	n/a	n/a	Vertical	n/a
ControlType	The type of control used to operate the damper (e.g., Open/Closed Indicator, Resetable Temperature Sensor, Temperature Override, etc.)	IfcString	see type	see type	empty string	n/a
SleeveLength	The length of the damper sleeve	IfcLengthMeasure	see type	see type	0.0	n/a
SleeveThickness	The thickness of the damper sleeve	IfcLengthMeasure	see type	see type	0.0	n/a
DamperLocationInSleeve	The location within the sleeve where the damper is mounted (e.g., Center)	IfcString	see type	see type	empty string	n/a
Actuator	Actuator references an Pset_Actuator AttDef which contains the actuator information, if an actuator is part of the damper assembly	Ref [IfcAttDef]	n/a	n/a	NIL	n/a
Pset_FireSmokeDamper						
Purpose	This property set will be used by an IfcDamper object to define the characteristics of a combination smoke and fire damper					
FrameThickness	The thickness of the damper frame	IfcLengthMeasure	see type	see type	0.0	n/a
FireResistanceRating	Enumeration that identifies the fire resistance rating of the damper	Enum [1-1/2Hour, 3Hour]	n/a	n/a	1-1/2Hour	n/a
BladeType	The type of blade used in the damper (e.g., Triple Vee, Fabricated Airfoil, Extruded Airfoil, etc.)	IfcString	see type	see type	empty string	n/a
Mounting	Enumeration that identifies how the damper is mounted in the building	Enum [Horizontal, Vertical]	n/a	n/a	Vertical	n/a
FusibleLinkTemperature	The temperature that the fusible link melts	IfcThermodynamicTemperatureMeasure	see type	see type	0.0	n/a
ControlType	The type of control used to operate the damper (e.g., Open/Closed Indicator, Resetable Temperature Sensor, Temperature Override, etc.)	IfcString	see type	see type	empty string	n/a
SleeveLength	The length of the damper sleeve	IfcLengthMeasure	see type	see type	0.0	n/a
SleeveThickness	The thickness of the damper sleeve	IfcLengthMeasure	see type	see type	0.0	n/a
DamperLocationInSleeve	The location within the sleeve where the damper is mounted (e.g., Center)	IfcString	see type	see type	empty string	n/a
Actuator	Actuator references an Pset_Actuator AttDef which contains the actuator information, if an actuator is part of the damper assembly	Ref [IfcAttDef]	n/a	n/a	NIL	n/a
Pset_BackdraftDamper						
Purpose	This property set will be used by an IfcDamper object to define the characteristics of a backdraft damper					

			FrameType	The type of frame used by the damper (e.g., Standard, Single Flange, Single Reversed Flange, Double Flange, etc.)	IfcString	see type	see type	empty string	n/a
			Actuator	Actuator references an Pset_Actuator AttDef which contains the actuator information, if an actuator is part of the damper assembly	Ref [IfcAttDef]	n/a	n/a	NIL	n/a
	Pset_ControlDamper								
		Purpose		This property set will be used by an IfcDamper object to define the characteristics of a control damper					
			DesignAirVelocity	The design air velocity for the damper assembly	IfcLinearVelocityMeasure	see type	see type	0.0	n/a
			BladeAction	Enumeration that identifies the blade closing action for the damper	Enum [Parallel, Opposed]	n/a	n/a	Parallel	n/a
			BladeType	The type of blade used in the damper (e.g., Triple Vee, Fabricated Airfoil, Extruded Airfoil, etc.)	IfcString	see type	see type	empty string	n/a
			BladeMaterial	The primary material used to construct the damper blade	Ref [IfcMaterial]	n/a	n/a	NIL	n/a
			BladeThickness	The thickness of the damper blade	IfcLengthMeasure	see type	see type	0.0	n/a
			FrameType	The type of frame used by the damper (e.g., Standard, Single Flange, Single Reversed Flange, Double Flange, etc.)	IfcString	see type	see type	empty string	n/a
			FrameMaterial	The primary material used to construct the damper frame	Ref [IfcMaterial]	n/a	n/a	NIL	n/a
			FrameThickness	The thickness of the damper frame	IfcLengthMeasure l	see type	see type	0.0	n/a
			Actuator	Actuator references an Pset_Actuator AttDef which contains the actuator information, if an actuator is part of the damper assembly	Ref [IfcAttDef]	n/a	n/a	NIL	n/a
	Pset_Louver								
		Purpose		This property set will be used by an IfcDamper object to define the characteristics of a louver					
			FrameType	The type of frame used by the louver (e.g., Standard, Drainable, etc.)	IfcString	see type	see type	empty string	n/a
			FrameThickness	The thickness of the louver frame	IfcLengthMeasure	see type	see type	0.0	n/a
			BladeType	The type of blade used in the louver (e.g., "J", "K", Cheveron, Sightproof, Drainable, etc.)	IfcString	see type	see type	empty string	n/a
			BladeThickness	The thickness of the louver blade	IfcLengthMeasure	see type	see type	0.0	n/a
			ScreenType	The type of screen used in the louver (e.g., Birdscreen, Insect Screen, etc.)	IfcString	see type	see type	empty string	n/a
			Actuator	Actuator references an Pset_Actuator AttDef which contains the actuator information, if an actuator is part of the louver assembly	Ref [IfcAttDef]	n/a	n/a	NIL	n/a
	Pset_LinearActuator								
		Purpose		This property set will be used by an IfcControlElement object to define the characteristics of a linear actuator					
			FailDirection	Enumeration that identifies the behavior of the actuator in case of power failure	Enum [FailIn, FailOut]	n/a	n/a	FailIn	n/a
			Force	Indicates the maximum close-off force for the actuator	IfcForceMeasure	see type	see type	0.0	n/a
			Stroke	Indicates the maximum distance the actuator must traverse	IfcLengthMeasure	see type	see type	0.0	n/a
	Pset_RotationalActuator								
		Purpose		This property set will be used by an IfcControlElement object to define the characteristics of a rotational actuator					
			FailDirection	Enumeration that identifies the behavior of the actuator in case of power failure	Enum [FailClockwise, FailCounterClockwise]	n/a	n/a	FailClockwise	n/a
			Torque	Indicates the maximum close-off torque for the actuator	IfcTorqueMeasure	see type	see type	0.0	n/a
			Range	Indicates the maximum rotation the actuator must traverse	IfcPlaneAngleMeasure	see type	see type	0.0	n/a
	Pset_Sensor								
		Purpose		This property set will be used by an IfcControlElement object to define the characteristics of a sensor					
			SensorType	Enumeration that identifies the type of sensor	Enum [Flow, Pressure, Temperature, Gas, Concentration, Volts, Amps, Density, Viscosity, Energy, Humidity, Other]	n/a	n/a	Flow	n/a
			SensorDescription	Further elaboration on the type of sensor	IfcString	n/a	n/a	empty string	n/a
			SensedMedium	The medium interacting with the sensor	Ref[Pset_Fluid]	n/a	n/a	NIL	n/a
			SensorRange	The range of the sensor	REAL	0.0	0.0	0.0	n/a
			SensorAccuracy	The accuracy of the sensor	REAL	0.0	0.0	0.0	n/a

Pset_Controller						
Purpose	*This property set will be used by an IfcControlElement object to define the characteristics of a controller*					
InputObjects	*Objects having an input to the controller*	*List [0:N] Ref [IfcObject]*	*n/a*	*n/a*	*NIL*	*n/a*
OutputObjects	*Objects that have an output from the controller*	*List [0:N] Ref [IfcObject]*	*n/a*	*n/a*	*NIL*	*n/a*
Pset_ControlElementAnalogInput						
Purpose	*Analog input for a control element*					
Units	*BACnetEngineeringUnits definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
HighLimit	*The high limit value (optional)*	*REAL*	*0.0*	*0.0*	*0.0*	*n/a*
LowLimit	*The low limit value (optional)*	*REAL*	*0.0*	*0.0*	*0.0*	*n/a*
Deadband	*The deadband value (optional)*	*REAL*	*0.0*	*0.0*	*0.0*	*n/a*
LimitEnable	*BACnetLimitEnable definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
EventEnable	*BACnetEventTransitionBits definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
NotifyType	*BACnetNotifyType definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
Pset_ControlElementAnalogOutput						
Purpose	*Analog output for a control element*					
Units	*BACnetEngineeringUnits definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
HighLimit	*The high limit value (optional)*	*REAL*	*0.0*	*0.0*	*0.0*	*n/a*
LowLimit	*The low limit value (optional)*	*REAL*	*0.0*	*0.0*	*0.0*	*n/a*
Deadband	*The deadband value (optional)*	*REAL*	*0.0*	*0.0*	*0.0*	*n/a*
LimitEnable	*BACnetLimitEnable definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
EventEnable	*BACnetEventTransitionBits definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
NotifyType	*BACnetNotifyType definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
Pset_ControlElementBinaryInput						
Purpose	*Binary input for a control element*					
Polarity	*BACnetPolarity definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
InactiveText	*Inactive Text (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
ActiveText	*Active Text (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
AlarmValue	*BACnetBinaryPV definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
EventEnable	*BACnetEventTransitionBits definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
AckedTransitions	*BACnetEventTransitionBits definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
Pset_ControlElementBinaryOutput						
Purpose	*Binary output for a control element*					
Polarity	*BACnetPolarity definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
InactiveText	*Inactive Text (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
ActiveText	*Active Text (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
MinimumOffTime	*Minimum Off Time (optional)*	*IfcLocalTime*	*see type*	*see type*	*0:0*	*n/a*
MinimumOnTime	*Minimum On Time (optional)*	*IfcLocalTime*	*see type*	*see type*	*0:0*	*n/a*
FeedbackValue	*BACnetBinaryPV definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
EventEnable	*BACnetEventTransitionBits definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
AckedTransitions	*BACnetEventTransitionBits definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
Pset_ControlElementMultiStateInput						
Purpose	*Multi-state input for a control element*					
NumberOfStates		*INT*	*0*	*32726*	*0*	*n/a*
StateText		*List [0:?] IfcString*	*see type*	*see type*	*empty string*	*n/a*
AlarmValues	*(optional)*	*List [0:?] REAL*	*0.0*	*0.0*	*0.0*	*n/a*
EventEnable	*BACnetEventTransitionBits definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*

NotifyType	*BACnetNotifyType definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
Pset_ControlElementMultiStateOutput						
Purpose	*Multi-state output for a control element*					
NumberOfStates		*INT*	*0*	*32726*	*0*	*n/a*
StateText		*List [0:?] IfcString*	*see type*	*see type*	*empty string*	*n/a*
EventEnable	*BACnetEventTransitionBits definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
NotifyType	*BACnetNotifyType definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
Pset_ControlElementEventEnrollment						
Purpose	*The events which a control element participates*					
EventType	*BACnetEventType definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
NotifyType	*BACnetNotifyType definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
EventParameters	*BACnetEventParameter definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
ObjectPropertyReference	*BACnetObjectPropertyReference definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
EventEnable	*BACnetEventTransitionBits definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
Recipient	*BACnetRecipient definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
ProcessIdentifier	*BACnetEventTransitionBits definition (optional)*	*REAL*	*0.0*	*0.0*	*0.0*	*n/a*
IssueConfirmedNotifications	*(optional)*	*BOOL*	*FALSE*	*TRUE*	*FALSE*	*n/a*
Pset_ControlElementLoop						
Purpose	*Loop definition for a control element*					
NumberOfStates		*INT*	*0*	*32726*	*0*	*n/a*
OutputUnits	*BACnetEngineeringUnits definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
ManipulatedVariableReference	*BACnetObjectPropertyReference definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
ControlledVariableReference	*BACnetObjectPropertyReference definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
ControlledVariableUnits	*BACnetEngineeringUnits definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
SetpointReference	*BACnetSetpointReference definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
Action	*BACnetAction definition*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
PriorityForWriting		*List [0:?] REAL*	*0.0*	*0.0*	*0.0*	*n/a*
EventEnable	*BACnetEventTransitionBits definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
NotifyType	*BACnetNotifyType definition (optional)*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*

Type driven properties that vary for each occurrence

BS-1 Model

Control Elements

Pset_ElectricActuator						
Purpose	*This property set will be used by an IfcControlElement object to define the characteristics of an electric actuator*					
ManualOverride	*Identifies whether hand-operated operation is provided as an override*	*BOOL*	*FALSE*	*TRUE*	*FALSE*	*n/a*
InputPower	*Maximum input power requirement*	*IfcPowerMeasure*	*see type*	*see type*	*0.0*	*n/a*
Pset_PneumaticActuator						
Purpose	*This property set will be used by an IfcControlElement object to define the characteristics of a pneumatic actuator*					
ManualOverride	*Identifies whether hand-operated operation is provided as an override*	*BOOL*	*FALSE*	*TRUE*	*FALSE*	*n/a*
InputPressure	*Maximum input control air pressure requirement*	*IfcPressureMeasure*	*see type*	*see type*	*0.0*	*n/a*
InputFlowrate	*Maximum input control air flowrate requirement*	*IfcVolumetricFlowrateMeasure*	*see type*	*see type*	*0.0*	*n/a*

Pset_HydraulicActuator						
Purpose	*This property set will be used by an IfcControlElement object to define the characteristics of a hydraulic actuator*					
ManualOverride	*Identifies whether hand-operated operation is provided as an override*	*BOOL*	*FALSE*	*TRUE*	*FALSE*	*n/a*
InputPressure	*Maximum design pressure for the actuator*	*IfcPressureMeasure*	*see type*	*see type*	*0.0*	*n/a*
InputFlowrate	*Maximum hydraulic flowrate requirement*	*IfcVolumetricFlowrateMeasure*	*see type*	*see type*	*0.0*	*n/a*
Pset_HandOperatedActuator						
Purpose	*This property set will be used by an IfcControlElement object to define the characteristics of a hand operated actuator*					
ManualOverride	*Identifies whether hand-operated operation is provided as an override*	*BOOL*	*FALSE*	*TRUE*	*FALSE*	*n/a*
Design Criteria						
Pset_DuctDesignCriteria						
Purpose	*This property set will typically be used in conjunction with Pset_Fluid and Pset_Insulation.*					
DesignName	*A name for the design values*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
SizingMethod	*Enumeration that identifies the methodology to be used to size system components*	*Enum [ConstantFriction, ConstantPressure, StaticRegain]*	*n/a*	*n/a*	*ConstantFriction*	*n/a*
PressureClass	*Nominal pressure rating of the system components*	*IfcPressureMeasure*	*see type*	*see type*	*0.0*	*n/a*
LeakageClass	*Nominal leakage rating for the system components*	*IfcPressureMeasure*	*see type*	*see type*	*0.0*	*n/a*
FrictionLoss	*The pressure loss due to friction per unit length*	*IfcPressureMeasure/IfcLengthMeasure*	*see type*	*see type*	*0.0*	*n/a*
LiningType	*The insulating lining type to be used*	*Ref[Pset_Insulation]*	*n/a*	*n/a*	*NIL*	*n/a*
InsulationType	*The insulation type to be used*	*Ref[Pset_Insulation]*	*n/a*	*n/a*	*NIL*	*n/a*
ScrapFactor	*Sheet metal scrap factor*	*REAL*	*0.0*	*0.0*	*0.0*	*n/a*
DuctSealant	*Type of sealant used on the duct and fittings*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
MaximumVelocity	*The maximum design velocity of the air in the duct or fitting*	*IfcLinearVelocityMeasure*	*see type*	*see type*	*0.0*	*n/a*
AspectRatio	*The default aspect ratio*	*REAL*	*0.0*	*0.0*	*0.0*	*n/a*
MinimumHeight	*The minimum duct height for rectangular, oval or round duct*	*IfcLengthMeasure*	*see type*	*see type*	*0.0*	*n/a*
MinimumWidth	*The minimum duct width for oval or rectangular duct*	*IfcLengthMeasure*	*see type*	*see type*	*0.0*	*n/a*
Pset_DuctSystemDesignCriteria						
Purpose	*This property set will typically be used in conjunction with Pset_Fluid and Pset_Insulation*					
SystemType	*Enumeration that identifies the type of system*	*Enum [VariableAirVolume, ConstantVolume, DoubleDuct]*	*n/a*	*n/a*	*VariableAirVolume*	*n/a*
SystemDescription	*System description*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
SystemLocation	*Physical description of the part of the building the system serves*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
Pset_PipeDesignCriteria						
Purpose	*This property set will typically be used in conjunction with Pset_Fluid and Pset_Insulation.*					
DesignName	*A name for the design values*	*IfcString*	*see type*	*see type*	*empty string*	*n/a*
SizingMethod	*Enumeration that identifies the sizing method to be used if different from the system design criteria*	*Enum [ConstantFriction, ConstantPressure]*	*n/a*	*n/a*	*ConstantFriction*	*n/a*
PressureClass	*Nominal pressure rating of the piping system components (i.e., 125, 250, etc.)*	*IfcPressureMeasure*	*see type*	*see type*	*0.0*	*n/a*
MaximumVelocity	*The maximum allowable fluid velocity*	*IfcLinearVelocityMeasure*	*see type*	*see type*	*0.0*	*n/a*
InsulationType	*The insulation type to be used*	*Ref[Pset_Insulation]*	*n/a*	*n/a*	*NIL*	*n/a*
Pset_PipeSystemDesignCriteria						
Purpose	*This property set will typically be used in conjunction with Pset_Fluid and Pset_Insulation*					
SystemType	*Enumeration that identifies the type of system*	*Enum [DomesticHotWater, ChilledWater,*	*n/a*	*n/a*	*ChilledWater*	*n/a*

		CondenserWater, HeatingHotWater, Steam]				
SystemDescription	System description	IfcString	see type	see type	empty string	n/a
SystemLocation	Physical description of the part of the building the system serves	IfcString	see type	see type	empty string	n/a
FluidSourcePressure	Pressure in main for domestic water, sprinklers, system pressure for hydronic systems, etc.	IfcPressureMeasure	see type	see type	0.0	n/a
FluidLiftHeight	Lift that may be required on open systems with dense fluids	IfcPressureMeasure	see type	see type	0.0	n/a
Physical Connection Sizes						
Pset_RectangularDuctConnection						
Purpose	This property set provides size information about a rectangular duct connection					
Width	Width of rectangular duct	IfcLengthMeasure	see type	see type	0.0	n/a
Height	Height of rectangular duct	IfcLengthMeasure	see type	see type	0.0	n/a
ConnectionType	Enumeration that identifies the type of connection	Enum [DriveSlip, S-Slip, Flanged, SlipOn, StandingSeam, Angles, Other]	n/a	n/a	Flanged	n/a
Pset_RoundDuctConnection						
Purpose	This property set provides size information about a round duct connection					
Diameter	Diameter of round duct	IfcLengthMeasure	see type	see type	0.0	n/a
ConnectionType	Enumeration that identifies the type of connection	Enum [BeadedSleeve, Drawband, OutsideSleve, Flanged, Crimp, Swedge, Other]	n/a	n/a	Flanged	n/a
Pset_OvalDuctConnection						
Purpose	This property set provides size information about an oval duct connection					
Width	Width of oval duct	IfcLengthMeasure	see type	see type	0.0	n/a
Height	Height of oval duct	IfcLengthMeasure	see type	see type	0.0	n/a
ConnectionType	Enumeration that identifies the type of connection	Enum [BeadedSleeve, Drawband, OutsideSleve, Flanged, Crimp, Swedge, Other]	n/a	n/a	Flanged	n/a
Pset_PipeConnection						
Purpose	This property set provides size information about a pipe connection					
NominalDiameter	Nominal diameter of pipe	IfcLengthMeasure	see type	see type	0.0	n/a
ConnectionType	Enumeration that identifies the type of connection	Enum [Flanged, Screwed, Welded, BellAndSpigot, Threaded, Other]	n/a	n/a	Flanged	n/a
CoordinationRequirement						
Pset_CoordinationRequirement						
Purpose	This property set provides a placeholder for interoperable coordination requirements between different disciplines					
OriginatingActor	The actor which originates the coordination requirement	Ref [IfcActor]	see type	see type	NIL	n/a
AffectedActor	The actor which must act upon the coordination requirement	Ref [IfcActor]	see type	see type	NIL	n/a
Requirement	The coordination requirement	IfcString	see type	see type	empty string	n/a

6.4. [BS-3] Pathway Design and Coordination

6.4.1. Object Types

None defined in this project

6.4.2. Type Definitions

None defined in this project

6.4.3. Property Sets

None defined in this project

6.5. [BS-4] HVAC Loads Calculation

6.5.1. Object Types

None defined in this project

6.5.2. Type Definitions

None defined in this project

6.5.3. Property Sets

None defined in this project

6.6. [CS-1] Code Checking - Energy Codes

6.6.1. Object Types

None defined in this project

6.6.2. Type Definitions

None defined in this project

6.6.3. Property Sets

None defined in this project

6.7. [CS-2]

6.8. [ES-1]

6.9. [FM-3]

6.10. [FM-4]

6.11. [SI-1]

6.12. [XM-2]

7. Model Design Validation Test Cases

7.1. Introduction

This section is included to inform implementers about the kind of project data that users expect to be able to develop using applications supporting this release of IFC. Therefore, we have included representative data sets for the elements involved in each of the usage scenarios defined in Section 2. Implementers are encouraged to use these data sets in the process of implementing, as a tool for validating their designs and as a precursor to the conformance certification process defined in the Conformance and Certification Process Guide.

Interoperability between applications must retain the integrity and consistency of the data. For example, a "primary" CAD user designs a building using an IFC compliant CAD system (system A).The user might define a door type as D1. The user wants to get a price for the door, so he links to an IFC compliant pricing application (system B) which categorizes doors differently. For example door D1 in system A is 'mapped' into door X3 in system B.

The user is unconcerned with the internal mapping which occurs in system B or between systems A and B, PROVIDED that the data which is returned is consistent with the data sent (i.e., the price returned relates to the original door D1).

7.1.1. Scope

This section provides sample test cases for use in validating the model and for use by application developers in validating software design.

At least one test case is provided for each end user scenario defined in section 2.

7.1.2. Background

The test case building is an adapted copy of the test building developed for the ATLAS project in Europe.

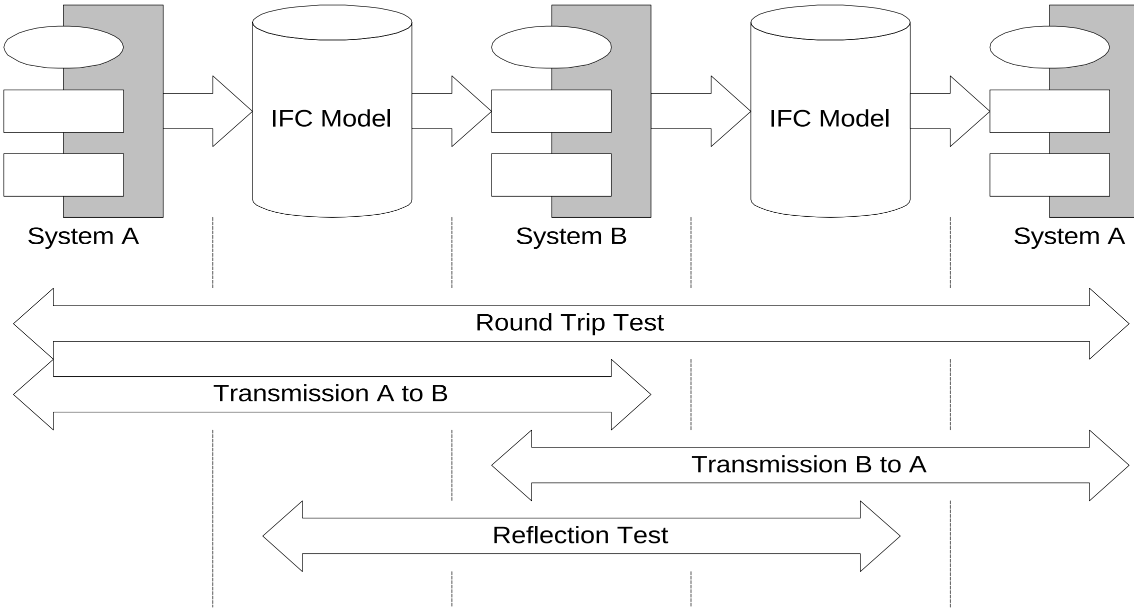
7.1.3. References

None

7.2. Test Procedures

This section is intended to be introductory in nature and is provided for background on the testing procedures that implementers will utilize.

This section should be reviewed for appropriateness prior to final printing of the Specifications; information contained herein should probably be moved to Volume D: IFC Certification Process.



There are a number of different 'data flows' implied by the general term 'interoperability'. What we have observed here is the importance of defining appropriate test cases which can be used in these different types of interoperability. Subsequently, the following different types of conformance testing methods have been defined:

7.2.1.1. Round Trip Test

A round trip test is conducted when data from system A is mapped into some agreed common intermediate format (in this case the IFC), mapped from the IFC into system B, and back via the IFC to system A. This test provides the most informative results, because it forces an application’s data to be interpreted by a different application and subsequently re-interpreted by the originating application. This test should be performed by implementers creating multiple IFC compliant applications that utilize overlapping datasets; or by similar applications utilizing different host IFC implementations.

The reporting format would be used to record the entities and attributes during this round trip. Some data may make the complete trip, other data is added by system B (as in the case of the door price example above).

In the round trip test, it is assumed that data originating in system A is returned to system A in the same form, and that data added by system B is consistent with the data of system A.

7.2.1.2. Transmission Test (A to B or B to A)

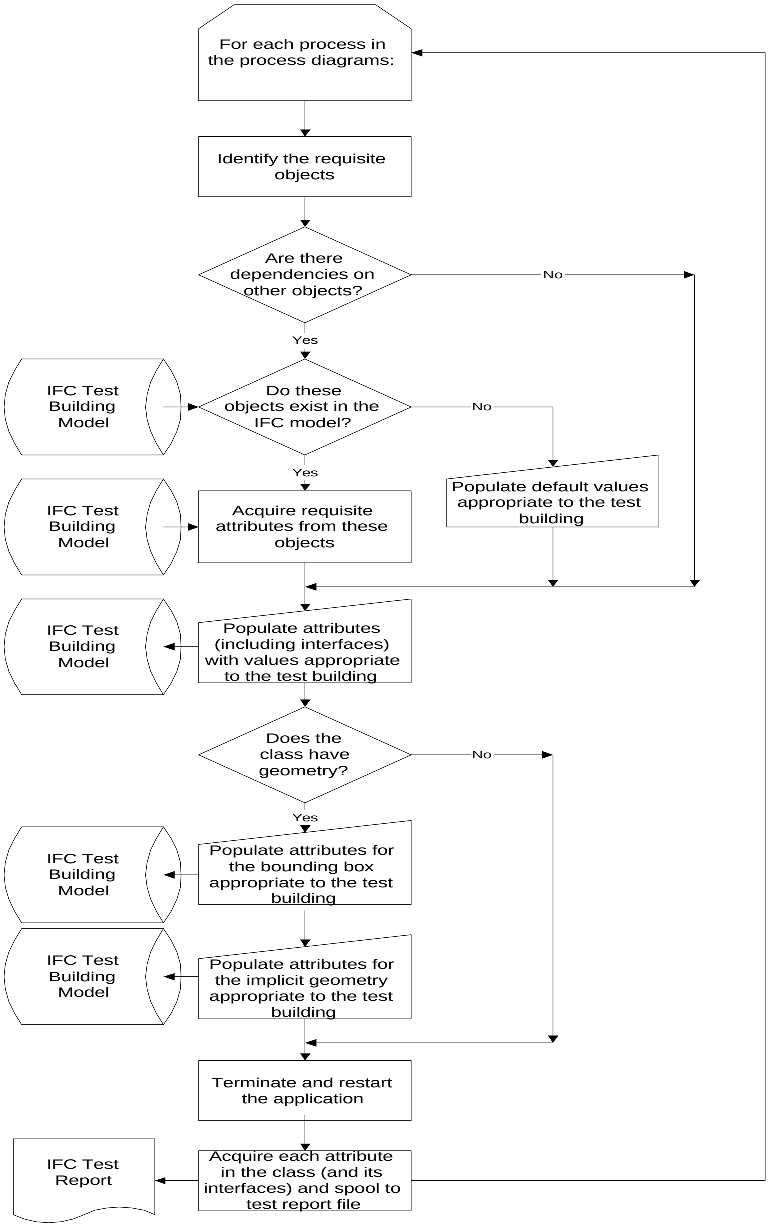
Starting with data in one system, map that data through the IFC to another system. In a transmission test it would be normal to assume that data in the receiving system have the same semantic meaning as in the transmitting systems. The effectiveness of the transmission not only depends on whether the two systems share similar semantic concepts, but also whether the IFC's have the capacity to transmit these concepts. This test should be performed by implementers creating multiple IFC compliant applications that utilize overlapping datasets; or by similar applications utilizing different host IFC implementations.

7.2.1.3. Reflection Test

Starting with data in the form of IFC, read this data into an application and return it to the form of the IFC. In the reflection test it would be normal to assume that the output data was equal to the input data. This test is the weakest in terms of determining IFC compliance, and should only be used by implementers creating a single IFC compliant application; or by a single application used within a single host IFC implementation.

7.2.1.4. Testing

This section will ultimately reside in Volume D: IFC Certification Process. It is included here for comment only.



7.2.2. Sample Building Used in the Test Cases

For consistency, the ATLAS Project test building was used as a model for a sample building. This model has been enhanced to create spaces that will allow testing of IFC applications based on this specification. An AutoCAD drawing file of the building can be found on the interoperability FTP site for use in testing.

The building is a two story warehouse with brick walls, reinforced concrete columns, and a reinforced concrete roof. The building is rectangular (30.3 meters in length and 16.125 meters in width) with a floor to floor height of 4.0 meters.

The building has glazing on the south-facing exposure. The glazing consists of two rows of six 1.8 x 4 m windows. The windows have a sill height of 0.875 m above the finished floor.

There are two offices on the south-west ground floor. These offices have a 10 mm thick dropped acoustical tile ceiling on a 600 x 600 cm spacing located 3.2 m above the finished floor. The first office is rectangular with 4890.0 x 5445.0 mm dimensions. The second office is L-Shaped with 9945.0 mm x 3950.0 mm dimensions along the outside wall and a 5395.0 x 1445.0 mm dimension in the interior.

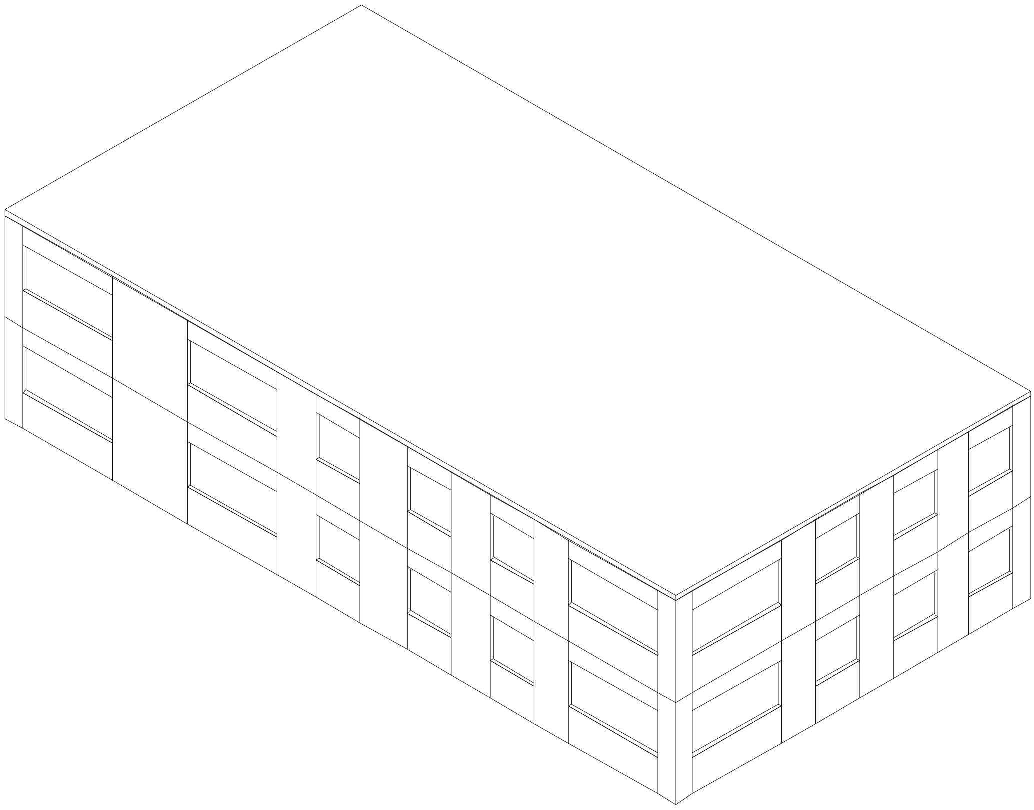


Figure 7-1: Isometric view of the test building observed from the South-East direction.

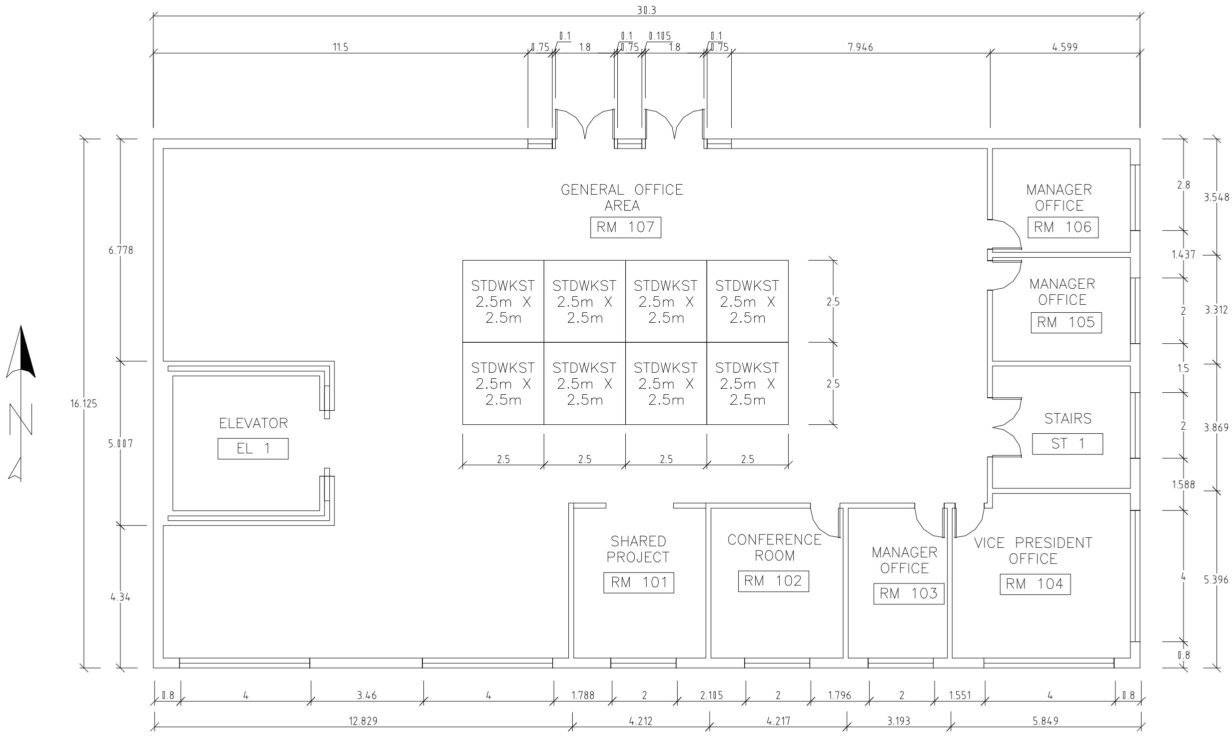


Figure 7-2: First floor plan view of the test building.

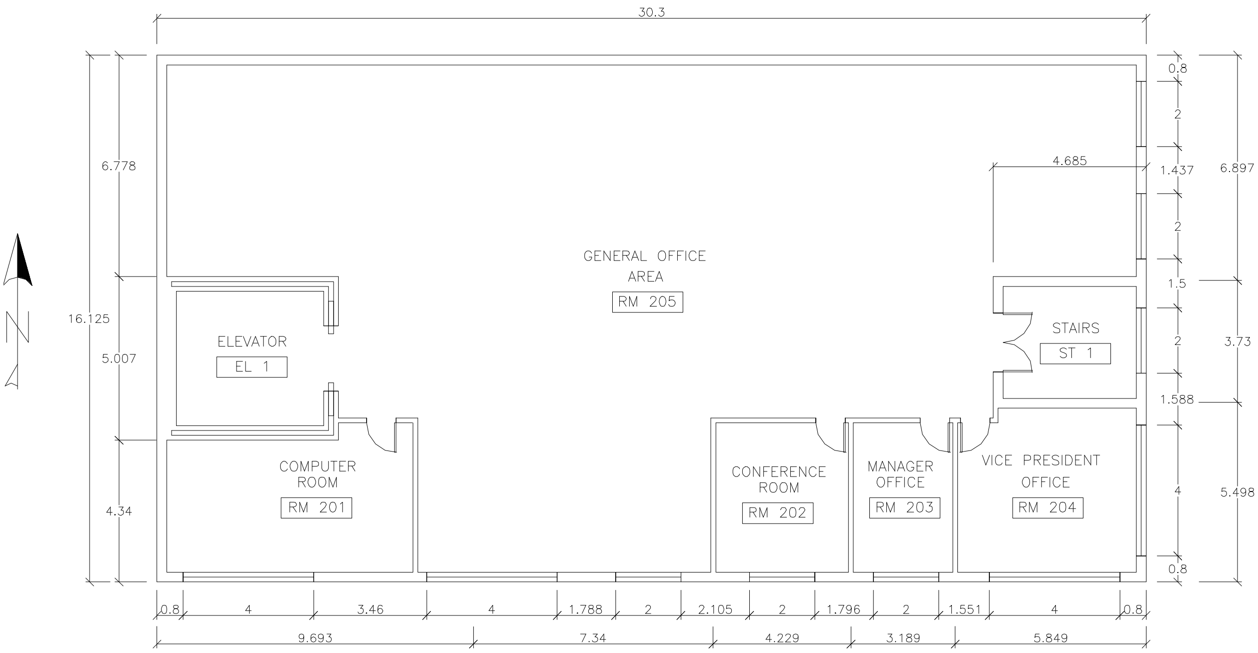


Figure 7-3: Second floor plan view of the test building.

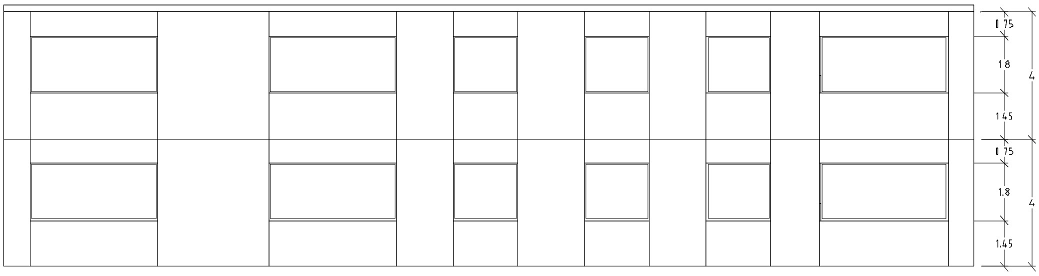


Figure 7-4: South Elevation

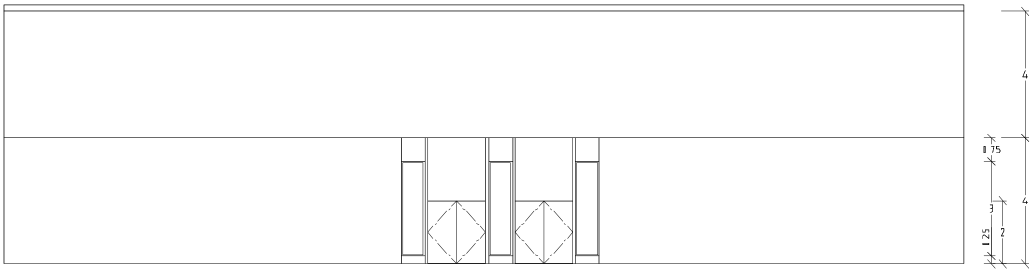


Figure 7-5: North Elevation

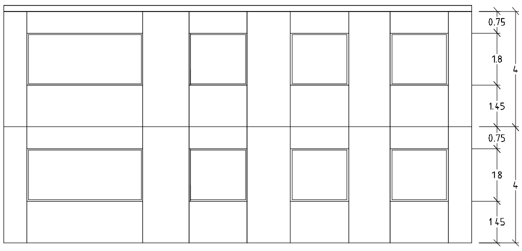


Figure 7-6: East Elevation

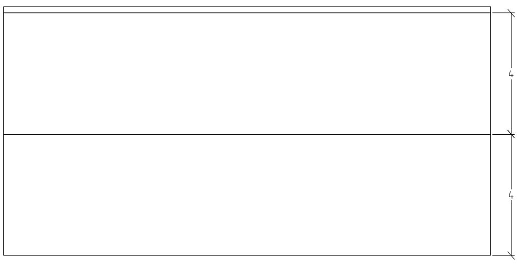


Figure 7-7: West Elevation

7.3. [AR-1]

7.3.1. Test Case 1: xxx

7.3.1.1. Purpose of Test

xxx.

7.3.1.2. Test Procedure

xxx:

1) xxx:

xxx.

7.4. [AR-2]

7.4.1. Test Case 1: xxx

7.4.1.1. Purpose of Test

xxx.

7.4.1.2. Test Procedure

xxx:

2) xxx:

xxx.

7.5. [BS-1]

7.5.1. Test Case 1: xxx

7.5.1.1. Purpose of Test

xxx.

7.5.1.2. Test Procedure

xxx:

3) xxx:

xxx.

7.6. [BS-3]

7.6.1. Test Case 1: xxx

7.6.1.1. Purpose of Test

xxx.

7.6.1.2. Test Procedure

xxx:

4) xxx:

xxx.

7.7. [BS-4]

7.7.1. Test Case 1: xxx

7.7.1.1. Purpose of Test

xxx.

7.7.1.2. Test Procedure

xxx:

5) xxx:

xxx.

7.8. [CS-1]

7.8.1. Test Case 1: xxx

7.8.1.1. Purpose of Test

xxx.

7.8.1.2. Test Procedure

xxx:

6) xxx:

xxx.

7.9. [ES-1]

7.9.1. Test Case 1: xxx

7.9.1.1. Purpose of Test

xxx.

7.9.1.2. Test Procedure

xxx:

7) xxx:

xxx.

7.10. [FM-3]

7.10.1. Test Case 1: xxx

7.10.1.1. Purpose of Test

xxx.

7.10.1.2. Test Procedure

xxx:

8) xxx:

xxx.

7.11. [FM-4]

7.11.1. Test Case 1: xxx

7.11.1.1. Purpose of Test

xxx.

7.11.1.2. Test Procedure

xxx:

9) xxx:

xxx.

7.12. [SI-1]

7.12.1. Test Case 1: xxx

7.12.1.1. Purpose of Test

xxx.

7.12.1.2. Test Procedure

xxx:

10) xxx:

xxx.

7.13. [XM-2]

7.13.1. Test Case 1: xxx

7.13.1.1. Purpose of Test

xxx.

7.13.1.2. Test Procedure

xxx:

11) xxx:

xxx.